THE USE OF PROMPTS IN TEACHING
PEOPLE WITH A LEARNING DISABILITY

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THESIS ABSTRACT

TITLE: The Use of Prompts in Teaching People with a Learning Disability

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The thesis reviews existing research on the use of prompts in teaching people with a learning disability. The review suggests a wide range of inadequacies and omissions. Many traditional prompt types and procedures lack any adequate theoretical rationale or empirical validation. There is also a lack of empirical and theoretical work concerning the formal and circumstantial factors which may determine their effect; and concerning their combined and comparative effects.

An attempt is made to remedy some of these deficits. The issues are discussed in theoretical terms from both a behavioural and a cognitive perspective. These theoretical accounts (particularly the cognitive one) are then used to suggest ways in which existing prompting practices may be refined, and to suggest some relatively novel practices.

The empirical investigations tested the effectiveness of some of these practices. Evidence is provided for the effectiveness of fading response prompts; of using stimulus prompts in teaching the motor and perceptual components of tasks; and of using mnemonic devices in teaching chained perceptuo-motor skills. In the circumstances of the studies reported, delaying the prompt and instructions to recall the required information failed to have an effect. The empirical work also provided evidence that, in some circumstances, full physical guidance can be less effective than alternatives, and delaying the prompt can be less effective than fading it.
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CHAPTER 1: SETTING THE AGENDA

In behavioural terms, a prompt may be defined as a behaviour on the part of the teacher (a response prompt), or an alteration or addition to the task stimuli (a stimulus prompt), which is intended to elicit the overt response being taught. Once the response is elicited in this way, it can be reinforced and the expectation is that it will thereby be strengthened. Response prompts may take the form of verbal instructions, modelling, gestures or physical guidance. In considering prompts, one must take into account not only the form assumed by the prompt (the prompt type), but also the procedure within which it is delivered. Procedural variables include such factors as the timing of the prompt's delivery and changes in the degree of assistance it provides. Prompts and the procedures within which they are delivered may be considered to be components of a prompting strategy. Each strategy will be a combination of one or more types of prompt with one or more procedures. The prompting strategy forms part of an overall teaching programme which includes other strategies such as that concerned with reinforcement.

Why do we need to investigate the prompting strategies used in teaching people with a learning disability? It is easy to gain the impression from the literature on behavioural teaching that there are few, if any, questions of substance still to be answered about this topic. A multitude of studies report the apparently successful application of the various teaching strategies available. Textbooks describe these strategies with confidence and give no indication of any uncertainty. The main concern appears to be the practical details of how the technology is to be applied to a particular task (Bower & Hilgard, 1981). The basic technology itself, it seems, does not need to be improved.

However, the impression may be a false one. The technology can, and probably often does, fail in its purpose. Research reports represent a biased sample, in that successes are more likely to be reported than failures (Stoddard & Gerovac, 1981; Clements, 1987). In any case, a more
careful study of the literature reveals a significant number of failures, particularly when the technology is applied to teaching those with more severe learning disabilities (Ellis et al., 1962; Schwartz et al., 1971; Koegel & Rincover, 1976; Whitman & Scibak, 1979; Harris, 1980; Bailey, 1981; Ellis et al., 1982; Clements, 1987). Indeed, this evidence has given rise to a debate about whether some of those with profound learning disabilities can be taught any useful skills (Bailey, 1981; Ellis et al., 1982).

In itself, this evidence of technological failure does not imply that the existing prompting strategies can be improved. As we have noted, prompting is only one part of a teaching programme and deficiencies in the other strategies that compose the programme may explain the failure; or, indeed, it may be the case that the learners in these studies would not have acquired the response whatever the nature of the teaching programme employed. Nevertheless, it does suggest that prompting strategies merit further investigation in order to determine whether improvements can be made.

Our investigation is divided into three parts. First, we shall evaluate existing research to determine whether there are any inadequacies or omissions in that work. Second, we shall attempt to remedy some of these flaws, and thereby to suggest some ways in which existing practices can be improved and to suggest some relatively novel practices. Finally, the empirical work will test the effectiveness of some of these established and novel practices.

In order to evaluate the existing research, we need to establish some general criteria against which it can be judged. We can group these criteria according to three basic issues - namely, how the research should select variables for investigation; what questions it should ask about those variables; and how it should seek to answer them. These issues are addressed in the remainder of the chapter.

1.1. ASKING THE RIGHT QUESTIONS

Since the research programme on prompting is an applied science, the informational needs of the technology determine what questions the
programme should address. The user of the technology needs to know which prompting strategy is best for any given set of circumstances. This, in turn, implies a need to know what the potential effects are of each of the available strategies (both positive and negative effects need to be considered), and what circumstantial factors (i.e., what task, individual and situational variables) determine the occurrence and magnitude of those effects. We can distinguish several types of effect that the user needs to take into account when selecting a strategy. Most important are the effects upon the acquisition of the taught response—that is, whether, and to what extent, the strategy increases the probability and/or speed of acquisition. Also to be considered are any effects upon the generalization and maintenance of the acquired response; the effects on other aspects of the learner’s functioning; and the practical implications (specifically, the demands made on teaching resources in terms of effort, expense, and expertise). The research programme, then, needs to supply the user of the technology with information about what effects each strategy may have in these areas, and how circumstances influence those effects.

A strong case can be made for suggesting that the research programme should supply this information in the form of information about the individual components that constitute the strategies, rather than about the strategies themselves. As already noted (p.1), there are two main categories of component—those relating to the prompt type, and those relating to procedure. Each strategy will be a combination of one or more types of prompt with one or more procedural components. The likely effects of each strategy in each set of circumstances can be calculated on the basis of a components analysis which supplies information about the potential effects of the component; how variation in the form of that component influences its effects; and how circumstantial factors influence its effects. Also necessary for calculating the effects of strategies is information about the effects of combining different components into one strategy—specifically, whether the combined effect can be greater (or less) than either individual effect, and in what circumstances such a relationship occurs. Further, in some instances it may not be possible or desirable to combine two particular components in the one strategy. To enable the user to make the correct choice between them, the analysis must provide information about whether one of them can
be superior in its effects and in what circumstances such superiority holds.

In summary, then, it is suggested that, for each component, the research programme needs to address the following questions:
1. Can it have an effect (positive or negative) on the probability and/or speed of acquisition, the generalization and maintenance of the acquired response, on other aspects of the learner's functioning, and on teaching resources?
2. How do variations in the form of the component influence those effects?
3. How do circumstantial factors influence those effects?
4. Can the effect of combining two components be greater (or less) than either individual effect? If so, in what circumstances does this relationship occur?
5. In cases where there may be reasons for not combining two components in the same strategy, can one be more effective than the other? If so, in what circumstances does this superiority hold?

If the concern of the technology is with composite strategies, why is it suggested that the research programme should concern itself with components? Why not address these questions with direct reference to the strategies? The reason is one of efficiency. Since strategies are combinations of two or more components and there are a significant number of components (and an even greater number of potential components), there are many more strategies than components (and a great many more potential strategies than potential components). A direct investigation of the strategies would therefore require a much greater volume of research. By investigating the effects of the components and their combined and comparative effects, we can provide a basis for calculating the effects of strategies which requires far less research effort.

1.2: SELECTING VARIABLES FOR INVESTIGATION - THE ROLE OF THEORY

How do we select which components to investigate, which formal variations of those components to investigate, and which circumstantial factors to investigate? And how do we select which pairs of components to investigate in respect of their combined and comparative effects?
Clearly we should investigate those already in use, or taken into account, within the existing technology. However, the primary role of the research programme is to improve and add to existing practices. We therefore need to address the question of how we should select other variables for investigation.

The issue of selection is not a pedantic one. We cannot commit ourselves to investigating all possible variables. For the range is endless. There is a multitude of possible components and within-component variations, and an even greater number of variable pairings and circumstantial variables. One strategy is to select variables at random. This has little to commend it. The number of variables which actually have an effect is presumably relatively small. Thus, given that the range of possible variables is endless, the ratio of possible to effective variables will be very high. Consequently, if we were to select variables at random, for every effective variable selected for investigation, a vast number of ineffective variables would also be selected and investigated. But, at least for the purposes of the technology which the research programme serves, the discovery of an effective variable is far more valuable than the discovery that a variable is ineffective. The latter is typically of interest only if it is a variable that is assumed to be effective within the existing technology, and we have already included these variables within the scope of the investigation. Consequently, a random selection would waste great quantities of research effort in the investigation of ineffective variables, and the rate of progress in discovering effective variables would be very slow. In short, a random selection constitutes a grossly inefficient research strategy.

Given that the discovery of an effective variable is more valuable, it makes more sense to concentrate the investigation on those variables which are considered likely to have an effect. A decision about the likely effects of a variable has to be made on the basis of theoretical speculation. We use the term 'theory' here in its broadest sense to mean an educated, but unproven, guess or hypothesis. It is to be distinguished from the narrower definition of the term which refers to a systematic set of propositions concerning the relationships amongst unobservable entities ('theoretical constructs') and observable entities.
Agenda

Theories about the likely effects of variables can be derived from a variety of sources. For example, common-sense beliefs play an important role in eliminating a wide range of variables likely to be ineffective (e.g., circumstantial factors such as the colour of the teacher's eyes or the contents of the learner's breakfast). Unexplained or unexpected patterns in the empirical data can also serve as the basis for a theoretical development. However, potentially the most valuable source of theoretical guidance is basic psychology ('basic' psychology is here contrasted with 'applied'). By drawing analogies and assuming equivalences between variables investigated in the basic research and variables in the prompting situation, we can use the findings and theories of the basic research to generate hypotheses about the likely effects of variables in the prompting situation.

In searching basic psychology for hypotheses about prompting, we should explore as many areas as possible, rather than restricting the search to a single area. For the more areas we search, the more likely we are to discover valuable hypotheses (Hyland, 1981). Clearly, though, we should give priority to those areas concerned with learning, and specifically to basic behavioural and cognitive research concerned with this issue.

The initial focus of this theoretical part of the programme should be to provide an account of the mechanisms whereby the component might have an effect. Such an account will, in turn, provide the basis for speculation about how formal and circumstantial factors may influence the effects of that component, and how they will compare or combine with the effects of other components.

Another valuable function of theories is worth mentioning. Until the research programme has supplied all the necessary empirical validation, the user of the technology will be faced in some circumstances with the problem of making a decision about what strategy to use in the absence of any empirical evidence to indicate what the most effective strategy will
be in these circumstances. Because they can indicate what is likely to be the case even in the absence of any empirical proof, theories can guide the user in making such decisions.

Objections

Such an approach to research is not without its critics. Skinner, who has exerted considerable influence on prompting research, rejected both the use of theories to guide research (Skinner, 1950 & 1969) and cognitive psychology (Skinner, 1974 & 1977). Against the use of theories to guide research (the 'hypothetico-deductive approach'), he espoused the 'inductive approach' to scientific investigation (Chalmers, 1978). According to this view, a scientific investigation should begin with a data-gathering stage, which is not guided by any preconceived ideas about what might be the case. Only when all the relevant data have been collected are we then permitted to derive 'empirical generalizations' (p.6) from them.

Skinner's main objection to the hypothetico-deductive approach was that relevant variables might be missed because of the inadequacies of the theories, and that theories preclude a more open-minded exploration of the topic under investigation and thereby cause the researcher to overlook relevant variables apparent in the empirical data (Chalmers, 1978; Hinson, 1987; Killeen, 1987). This objection can readily be countered. If required, a hypothetico-deductive research programme can investigate as many variables as an inductive investigation. The two programmes would be differentiated only by the order in which the variables were investigated (i.e. the hypothetico-deductive programme would begin by investigating those considered likely to be important). Moreover, there is no reason why a researcher using the hypothetico-deductive approach should not pursue the investigation of interesting effects revealed in the empirical data which were not predicted by the original theories (p.6). Furthermore, if the inductive approach does not guide its selection of variables, then it must investigate them in a random order. As we argued earlier (p.5), a random selection would waste great quantities of research effort in the investigation of ineffective variables, and the rate of progress in discovering effective variables would be very slow. Finally, we may note that Skinner himself did not
adhere to his inductivist principles. His work is full of assumptions and speculations about what might be the case, and he used these to guide his empirical investigations (Bethlehem, 1987). Indeed, it is ironic that one of Skinner's strengths as a psychologist was his imaginative ability to see potential equivalences between otherwise very different situations, and to use these equivalences to generate novel suggestions about how to predict and control behaviour. More fundamentally, we may suggest that Skinner's failure to adhere to his inductivist principles was inevitable. Prediction and thereby control are impossible within a purely inductive approach because the claim that one can derive theory-free empirical generalizations on the basis of observations runs into insurmountable logical difficulties (Chalmers, 1978).

Skinner's arguments against cognitive psychology have been discussed and refuted in detail elsewhere (e.g. Wessells, 1981, 1982 & 1987; Killeen, 1987). Here we confine ourselves to a brief consideration of his main objections:

1. He argued that cognitive psychology precludes the development of effective means of control over behaviour because it prevents attention being paid to environmental events and, from a psychological point of view at least, we can only control behaviour by the manipulation of environmental events. Against this, we should note that there is no logical reason why cognitive psychologists cannot pay attention to environmental events. Skinner's argument can only be defended as a psychological claim to the effect that cognitive psychology inclines its practitioners to avoid attending to environmental events. However, even in this form, the claim must be rejected. As we shall see in the case of investigating the factors that determine memory recall (Section 7.2), cognitive psychologists do sometimes pay considerable attention to the question of which environmental variables can be manipulated in order to influence internal processes and thereby behaviour.

2. Skinner also claimed that the concepts used in cognitive psychology are vague, logically circular and meaningless. Certainly some mentalistic and cognitive concepts are vulnerable to this accusation in that they lack any precise and substantial meaning apart from that endowed by the observation they are intended to explain. However, this
is by no means true of all such concepts. Generally speaking, the established concepts used by modern cognitive psychology are embedded within a considerable body of interconnected theoretical propositions and empirical evidence which endows them with a substantial and relatively precise meaning.

3. Skinner pointed out that the explanations of cognitive psychology appeal to unobservable fictional entities ('theoretical constructs') whose existence can never be empirically proven precisely because they are unobservable. Presumably the intended implication of this point is that explanations in terms of such entities cannot provide a sound basis for scientific progress. However, the validity of this implication is undermined by the success of such sciences as physics. Physics must be considered one of the flagships of scientific progress, but its explanations make considerable use of unobservable fictional entities (Wessells, 1987; Hall, 1987; Killeen, 1987).

4. Skinner also argued that, in any case, it is unnecessary to appeal to these unobservable cognitive constructs because all behaviour (under which term he included covert mental responses) can be accounted for in environmental or physiological terms. Although it may be true that in theory an explanation of all behaviour could be given in these terms, nevertheless cognitive explanations still hold some attraction in that, at least in some respects, they are easier in practice to investigate and validate (Hyland, 1981; Wessells, 1987). Consider, for example, the investigation of individual differences - which is relevant in the present context because individual differences constitute an important type of circumstantial variable. A cognitive account will offer an explanation of these differences in terms of variation in some current characteristic of the individuals. A behavioural account must do so in terms of differences in the environmental histories of the individuals. The latter will typically be more difficult to investigate (i.e. it will consume more research resources). For example, it requires fewer resources to measure individual variation in some current disposition to react negatively to failure, than to measure variations in individual environmental history which produced that disposition. As this example also illustrates, the behavioural account will also be more difficult to validate. Indeed, it will often be impossible to do so, since the
environmental histories of the individuals concerned are most unlikely still to be available. Indeed, the practical inaccessibility of personal history and individual physiology makes it most unlikely that we would ever be in a position to explain all behaviour in the terms that Skinner suggests. In any case, even if this were eventually achieved, an argument can be made for the retention of the cognitive approach in the interim. As long as we need to conduct further research, cognitive psychology offers an additional and potentially fruitful means of generating hypotheses to guide this research and this, we have argued (p.5), is the most efficient approach to the task. For, although there may be some overlap, behavioural and cognitive psychology are most unlikely to generate exactly the same set of hypotheses as a guide to prompting research. The nature of the hypotheses generated is dependant on the content of the theoretical propositions and empirical evidence that constitute each area of research, plus, in the case of cognitive psychology, the nature of the models of non-psychological systems (e.g. information processing) that are used to generate hypotheses by analogy (Hyland, 1981; Richards, 1989). The differences between the two areas in these respects are sufficiently great to ensure significant differences in the hypotheses generated.

In this context, it is of interest to consider the attempts that have been made to describe the unobservable entities and events that constitute the subject matter of cognitive psychology in behavioural terms (Sidman, 1978 & 1979; Ager, 1983). This move is to be welcomed if it represents an attempt to identify similarities and improve communication between the two areas. For this provides another way of generating more hypotheses to guide research (Hyland, 1981). By assuming an equivalence or similarity between two concepts taken from different areas of psychology, one can use information from one area about one concept to speculate about what might be true about the other concept in the other area. However, the move is to be rejected if it is a reductionist ploy - that is, if the implication is that the cognitive approach should be abandoned as being no longer necessary. This would be unwise for the reasons given in the previous paragraph.
We have suggested a list of questions that the research programme should address concerning existing and potentially effective components (p.4). In this section we discuss some methodological issues related to answering those questions. Some of the points made will seem obvious. However, they are explicitly discussed because, as we shall see in later chapters, they are frequently overlooked in the existing research.

The first question concerns whether the component has a relevant effect. To test this experimentally, it is necessary to compare the effects of a teaching programme which contains that component, with the effects of a programme which does not contain it but is otherwise identical. It is not, of course, sufficient simply to observe the outcome when a teaching programme which contains that component is applied. For in this case no experimental control is exercised over the other variables in the situation. The outcome could be attributable to some other component in the prompting strategy, some component of the teaching programme which is not part of the prompting strategy or, indeed, to some variable which does not even constitute part of the programme.

The second and third questions concern how variations in the form of the component or in the circumstances of teaching might influence the relevant effects. Ideally, this should be investigated by observing the effects consequent upon a systematic variation in these variables. However, it will also be useful, particularly in the preliminary stages of an investigation, to observe the effects even after unsystematic variation. Because the variation is uncontrolled, any relationship between it and variation in the relevant effects will be merely correlational. Nevertheless, the occurrence of such a relationship may still prove useful in generating hypotheses to guide subsequent research (p.6), and in providing preliminary circumstantial evidence in favour of a hypothesis. We should also note that, in practice, the circumstantial factors relating to individual differences amongst learners cannot be experimentally varied. In this case we are compelled to settle for correlational support of any hypothesis.
The second and third questions also concern interactions - that is, how the probability and magnitude of an effect may vary with form or circumstance. There is one such interaction effect which is presumably general to all components. As the task being taught becomes very easy or very difficult for the particular learner involved, so the effects of a component may be expected to diminish. The task may be so easy that the learner will acquire it, or so difficult that the learner will not acquire it, whatever the nature of the teaching strategy. The possibility of such floor and ceiling effects needs to be borne in mind when investigating the effects of specific formal or circumstantial variables.

The fourth question concerns whether the combined effect of two components is greater than either used individually. The appropriate experimental design to test this requires a comparison between a strategy which contains both, a strategy which contains one of the components, and a strategy which contains the other (the strategies being identical in all other respects). However, if one had strong theoretical or empirical grounds for supposing that one of the components could not have a significant effect without the other, then it would be sufficient to compare a strategy which contained only the latter with one which contained both.

The fifth question concerns which of two components has the greater effect. This needs to be tested by comparing a strategy which contains one of the components with a strategy which contains the other but is otherwise identical. Care must be taken in drawing general conclusions from any results obtained in such a comparison. The effects of a component vary with circumstances. Variation in circumstances probably influences the effects of different components in different ways. A particular set of circumstances may diminish, relatively speaking, the effects of one component, but increase the effects of another. Consequently, unless we have strong reasons for supposing otherwise, we should not infer from the superiority of one component over another in the particular circumstances of the study, that that component will always be superior, or even that it will always be either superior or at least as effective as the other component. A component may be superior to another in some circumstances, but inferior in others.
For the purposes of our future discussions of comparative studies, it will be useful to provide a terminology to describe these possible relationships between two components. Universal superiority refers to the relationship in which one of the components is superior in every set of circumstances; overall superiority refers to the relationship in which one component is either superior or at least as effective in all circumstances; mixed superiority refers to the relationship in which one of the components is superior in some circumstances, but inferior in others; and average superiority refers to the relationship in which one of the components is on average superior, the average being taken across all circumstances. It should be noted that knowledge that some component has average superiority over another is of little or no value to a user of the technology, since it does not allow the user to predict which component will be more effective in the particular circumstances for which a strategy has to be devised. Such predictions must be based on knowledge of the other types of relationship, plus knowledge about how circumstances influence those relationships.

A final point to be considered in this section concerns the nature of the dependant variables. In this investigation we shall be concentrating particularly on those effects which relate to the probability and speed of acquisition of the taught response. The probability of acquisition is measured with reference to some criterion of achievement, typically one or more instances of the learner emitting the response without assistance. Measurement of the speed of acquisition requires more comment. We need to take into account not only the time spent in face-to-face teaching (direct teaching time), but also the time spent in preparing and otherwise implementing the teaching trials (indirect teaching time). Indeed, the latter will often be considerably greater than the former. This is particularly likely to be the case when, as ideally they should be (Stokes & Baer, 1977), responses are taught in their natural context. For example, in teaching a person to make use of public transport in a natural context, the direct teaching will typically require a small amount of time relative to the time taken by the whole journey. In such cases it will be more important to take measures of the indirect time required. In comparing the efficiency of two strategies, a convenient index of this can often be provided by the number of teaching trials. For, unless the strategies differ in the degree of material
In comparing the effects of two components or strategies, it is conventional to refer to a difference in the probability of acquisition as a difference in effectiveness, and to a difference in the speed of acquisition as a difference in efficiency (Godby et al., 1987). We shall retain this convention when discussing comparative studies. However, it should be noted that when we suggest in other contexts that a component has an effect on acquisition, this can mean an effect either on the probability or the speed of acquisition. This ambiguity is maintained because it is often difficult to specify whether the effect is on speed or probability.

1.4: AGENDA

The purpose of the investigation is to generate suggestions about how prompting technology might be improved. This is to be achieved by a three part strategy - first, to evaluate existing research to determine whether there are any inadequacies or omissions; second, by remedying some of these defects, to suggest new practices and refinements to existing practices; and, third, to test empirically the effectiveness of some of these practices.

In order to carry this out, we have set out some general criteria whereby the existing research can be evaluated. In summary, we have suggested that research should focus on the effects of components, rather than strategies; and that the effects of interest relate to the probability and speed of acquisition, the generalization and maintenance of the acquired response, the demand on teaching resources, and other aspects of the learner's functioning. The research needs to provide information about which components have these effects; how formal variations within a component and circumstantial factors influence those effects; and what the combined and comparative effects of those
components are, and how circumstantial factors influence these effects. Some methodological guidelines were also provided for the empirical investigation of these issues. Furthermore, it was argued that research should be guided by theories about which variables (componential, formal and circumstantial) might have an effect, and about how they might interact. The most important element in this theorising should be an account of the mechanisms whereby a component can have an effect. In generating the theories, we should make use of whichever areas of basic psychology are relevant, including basic learning research in behavioural and cognitive psychology.

This provides us with the following framework for evaluating the research on each component:
- What empirical evidence is there that it can have an effect?
- By what mechanisms might it have that effect?
- How do formal variations in the component influence its effect?
- How do circumstantial factors influence its effect?

We also need to evaluate the research which has investigated its effects in comparison, or in combination, with other components.

Using this framework, we shall review the specific content of existing research. The two main categories of component are considered separately. Chapter 2 considers the research relating to prompt types, and Chapter 6 the procedural components. Although some consideration will be given to the other effects (on generalization and maintenance, teaching resources and other aspects of the learner's functioning), the main focus of the review will be the effects of components on the probability and speed of acquisition. This reflects a bias in existing research which is entirely appropriate given that, unless the component can facilitate acquisition, the other effects are of little interest.

We shall also be concerned to remedy some of the inadequacies and omissions revealed by the review, and thereby to derive suggestions about improving prompting practice. The behavioural and cognitive psychologies of learning are the main sources of the remedial theories, though other areas of basic psychology (e.g. personality theory) are also used. The cognitive psychology of learning has had little influence on the development of prompting research and technology (Ager, 1983).
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Consequently we shall need to describe a basic cognitive theory of learning and to describe, in general terms, how it applies to the use of prompt. This is done in Chapter 3 and 7. Chapters 4 and 7 discuss the specific theoretical implications of this account for prompt types and procedures respectively. The behavioural theories, and others which are not reliant on this cognitive account, are described in Chapters 2 and 6.

Chapters 5 and 8 contain the empirical work. The former concerns prompt types, and the latter procedures. The work is concerned to test the effectiveness both of existing components and of relatively novel components suggested by the theoretical speculation.

Before proceeding we should note some limitations on the scope of the study. First, we are concerned with the use of prompts to facilitate the initial acquisition of tasks, not with their use to enhance the speed and non-essential accuracy (i.e. not essential for the task's completion) with which an acquired task is completed. This reflects the fact that the primary concern in teaching people with learning disabilities is typically to ensure that they can complete a task effectively, rather than to refine an existing skill or response. Second, although the investigation has application to all types of learning, particular emphasis is placed on learning to make a specific overt motor response (the response component) to a specific external stimulus (the stimulus component). In other words, the emphasis is on perceptuo-motor learning at the expense of any particular consideration of cognitive skills and propositional knowledge. This emphasis reflects the fact that the main challenge for a prompting technology is presented by people with more severe learning disabilities, and for such people the acquisition of perceptuo-motor skills is more within their grasp and of greater relevance. Finally, the investigation is more concerned with the acquisition of specific, rather than general, skills. The acquisition of general perceptuo-motor skills is, of course, of great importance. However, research into the facilitation of their acquisition more properly belongs to a research programme concerned with generalization.
CHAPTER 2: REVIEW OF EXISTING RESEARCH - PROMPT TYPES

This chapter reviews the specific content of existing research as it relates to the different types of prompt. Research on the use of stimulus prompts in teaching choice discrimination tasks is considered first (2.1), then the use of response prompts (2.2), and finally the other applications of stimulus prompts (2.3). The review is conducted within the framework set out in the previous chapter (p.15). Thus, for each of these general types we discuss: the empirical evidence that it can have a facilitatory effect on the probability or speed of acquisition; the mechanisms of that effect; how formal variations within the type can influence it; and how circumstantial factors can influence it. Further sections consider the comparative effects of stimulus and response prompts (2.4), and the effects of combining prompts (2.5). The final section (2.6) considers the effects of the prompts other than their effect upon task acquisition.

2.1: STIMULUS PROMPTS IN CHOICE DISCRIMINATION LEARNING

2.1.1: Evidence of Effectiveness

There exists a substantial body of evidence demonstrating that stimulus prompts (i.e. prompts which alter or add to the task stimuli - p.1) can facilitate the learning of choice discrimination tasks by people with learning disabilities. Numerous studies have shown that a teaching strategy which includes stimulus prompts can be more effective than a strategy which does not include them but is otherwise identical ("no-prompt" or "trial-and-error" training) (e.g. House & Zeaman, 1960; Sidman & Stoddard, 1967; Touchette, 1968; Strand & Morris, 1988). Additional evidence of their effectiveness is provided by similar studies using young children (e.g. Spiker, 1959; Moore & Goldiamond, 1964) and animals (e.g. Lawrence, 1952; North, 1959; Terrace, 1963a, 1963b).
2.1.2: The Mechanisms of Effect

Skinner (1968) provides a behavioural account of how prompts can facilitate learning. A prompt is a stimulus which already controls (or at least is thought to control) the response to be taught. A prompt can thus ensure the rapid emission, and thereby reinforcement, of the response. If no prompts are given, then the first instance of the response may take a long time to occur, or it may not occur at all. On the assumption that the emission and reinforcement of the response is necessary and sufficient for acquisition to occur, it follows that prompts can be more effective than no-prompt training.

However, the emission and reinforcement of an overt response is not sufficient for the learning of that response to occur. This is clear from the many studies in which the prompts were functional (i.e. they reliably elicited the overt response during teaching) but ineffective (i.e. once the prompts were withdrawn, the rate of correct responding on the unprompted task was no better than after no-prompt training) (e.g. Koegel & Rincover, 1976; Jones & Cullen, 1980; Aeschleman & Higgins, 1982). In the light of this, Holland (1965) stressed an important refinement of Skinner's account (a refinement which, he noted, has often been overlooked in prompting research and practice). To be effective, the prompts must elicit not only the overt response, but also what Holland terms the 'necessary precursory behaviour'. It is difficult to find in Holland (1965) or elsewhere a general definition of necessary precursory behaviour (though he makes it clear that it may be overt or covert). We shall return to this issue later when discussing response prompts. In the present context, it will be sufficient to consider the specific definition that has been given with reference to choice discrimination learning. It is held to involve 'looking at' that feature (the 'relevant' or 'discriminating' feature) of the positive stimulus stimulus (the S+) which naturally and intrinsically distinguishes it from the negative stimulus (the S-). To be effective, the prompt must induce the learner to look at the relevant feature. A rationale for this can be given as follows (Schusterman, 1966; Touchette, 1971; Doran & Holland,

\footnote{It is not necessary either (see Bandura (1969) and Chapter 3), though it can be argued that, in this context at least, it is usually helpful.}
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1979): The only basis for reliably selecting the S+ when no prompts are available is that feature which naturally and intrinsically distinguishes it from the S-. Reliable independent performance on the discrimination will therefore occur only if the response comes under the control of that feature. The response will come under the control of that feature only if the learner looks at it. Therefore, the prompt must ensure that the learner looks at the relevant feature. Zaman and House (1963) made a related suggestion using the concept of attention. In order to acquire a discrimination, they suggest, the learner must first attend to the dimension which naturally differentiates the S+ and the S-, and then to the value of that dimension taken by the S+.

On this basis, a general account of how stimulus prompts can facilitate the acquisition of a discrimination can be offered (Lawrence, 1952; Spiker, 1959; House & Zaman, 1960; Schusterman, 1966; Gollin & Savoy, 1968; Touchette, 1971; Doran & Holland, 1979): Stimulus prompts can be effective because they can elicit the overt response and the necessary precursory behaviour (i.e. attention to the discriminating feature) more readily than can no-prompt training.

How can stimulus prompts elicit attention to the discriminating feature? A review of the prompts that have been used in the existing research suggests that, in general terms, they do this by increasing the 'attentional value' or 'noticeability' of the relevant difference or feature (though there is an exception to this). These terms refer to the probability of an item being attended, and specifically to that component of the probability which is determined by stimulus factors intrinsic to that item (as opposed to individual or situational factors). There are at least four specific ways of increasing the attentional value:

Type 1: Exaggerating the Relevant Difference
The first type involves the exaggeration of the relevant difference between the S+ and the S- (e.g. Lawrence, 1952; Spiker, 1959; Strand &

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1 This account is not complete. We also need to explain how performance on the prompted version can produce performance on the unprompted version. However, this is a procedural issue which will be considered in the appropriate chapter (Chapter 6).
Morris, 1988). For example, Lawrence (1952) taught a discrimination between two middling shades of grey by first teaching rats to discriminate two extreme shades. Presumably, larger differences have a higher attentional value.

Type 2: Eliminating Distractions
A difference can presumably be rendered more noticeable by eliminating the distraction provided by irrelevant stimuli. This can be done in two ways:
(a) First, by eliminating irrelevant features (Holland & Matthews, 1963; Schreibman, 1975). For example, part of Schreibman's procedure for teaching a discrimination between two figures holding their arms in different ways (the relevant feature) involved the initial presentation of the arms alone before the other irrelevant parts of the body were faded in.
(b) Second, by eliminating differences between the S+ and the S− on irrelevant features. For example, Cheney and Stein (1974) taught the task of selecting the odd stimulus from a set. The stimuli differed in size (an irrelevant difference) as well as shape (a relevant difference). One of the training conditions involved initially presenting the stimuli at a uniform size.

Type 3: Directive Prompts
The implicit rationale in several studies appears to be that the prompt, having attracted attention to itself, should then direct attention to the relevant feature or difference. The prompt is assumed to control an attentional response to the relevant feature/difference. Two types of control can be distinguished:
(a) Symbolic Prompts: Dowler et al. (1984) prompted a colour discrimination by means of a prompt card upon which there was a blob of the relevant colour, and a cut-out shape on a card prompted a shape discrimination. Presumably, the intention was that the learner should look at the card; that this should indicate to them in a symbolic way what the relevant dimension was; and that they should then look at this dimension in the task stimuli.
(b) Spatial Location: Several studies have highlighted the relevant feature of the stimuli in some way. For example, in teaching shape discriminations, some studies have highlighted it by means of colour
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(Guralnick, 1975; Wolfe & Cuvo, 1978), whilst others have thickened the feature (Guralnick, 1975; Rincover, 1978). For example, in teaching a discrimination between 'J' (S+) and 'S' (S-), Rincover thickened the top bar of the 'J' (i.e. 'J'). In seeking to offer an account of how this might facilitate detection of the relevant difference, a plausible assumption to make is that visual attention is influenced by spatial proximity. We may then suggest that if attention is directed to one aspect of a stimulus complex (in this case, the prompt), then, if other aspects are also attended, those in closer spatial proximity to the initially attended aspect (the prompt) are more likely to be attended. Thus highlighting may increase the probability of the learner detecting the relevant difference because it initially attracts attention to itself, and this increases the probability of attention then being paid to the relevant feature because of its spatial proximity to the prompt. For more able learners, highlighting may presumably also function in a symbolic way.

Type 4: Perceptual Prompts

North (1959) taught rats to discriminate between ' " ' and ' _ ' by first teaching them to discriminate ' \( \wedge \) ' and ' \( \Delta \) '. In a second study, he taught them to discriminate the orientation of bars by first teaching the task using larger bars (both the S+ and the S- were enlarged by the same amount). North made an unelaborated reference to Gestaltian principles as a rationale for this type of prompt. One possibility is that the prompts altered the way in which the learners perceived the stimuli such that the difference between the S+ and the S- became more apparent. For example, when the stimuli are sufficiently small, differences between them may not readily be perceived because the learner operates a cut-off point below which visual analysis does not normally proceed. Increasing the size of the stimuli may make such differences more perceptible by bringing them above this cut-off point. Other possible examples of this type of prompt are provided by House and Zeaman (1960) and Schreibman (1975). It needs to be theoretically distinguished from the third type of prompt. In the latter case, attention to the relevant feature is dependant upon attention to the prompt, but in the present case attention is considered to be drawn directly to the relevant feature.
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Type 5: Non-specific Prompts

This list does not provide a comprehensive system of classifying the prompts that have been used in existing research. We therefore require a fifth type which, for reasons which will become apparent, we shall term non-specific prompts. Characteristic of this type is that they involve the addition of a difference with a high attentional value on some dimension other than the relevant dimension. The difference may have a high attentional value because:

(a) In the manner of the first type of prompt, it is a large difference. For example, Schusterman (1966) taught a shape discrimination by introducing a large difference in size between the S+ and the S-. A particular example of this type is the 'fading-in' of the S-, which involves the introduction of a large difference on the dimension of luminance (e.g. Terrace, 1963a; Schreibman, 1975; Jones & Cullen, 1980).

(b) The values of some variables are categorical rather than continuous. A common type of prompt involves the addition of a categorical difference. Colour is often used for this purpose (e.g. Terrace, 1963b; Touchette, 1968; Koegel & Rincover, 1976). For example, Koegel and Rincover (1976), in attempting to teach shape discriminations, added a different colour to the S+ and the S-. Either these categorical differences are assumed to be ones to which the learner will readily attend, or prior training on discriminating the prompt-introduced difference is given (e.g. Touchette, 1968; Koegel & Rincover, 1976.).

What is the mechanism of effect of non-specific prompts? It is clear that they cannot draw the learner's attention directly to the relevant feature. However, because the difference introduced by the prompt will typically be easier to detect than the natural difference, it can ensure that the learner selects the S+ during prompt training with greater accuracy than during no-prompt training. If the identity of the S+ is clear during training, then the learner can eliminate certain potential differences in their search for the relevant difference - namely, those differences based upon the position of the stimuli. For example, it enables the learner to rule out the possibility that the S+ always appears on the right, or that it alternates between left and right (both of which are common errors in no-prompt training (Hively, 1962)).
Presumably, the learner's search for the relevant difference will be facilitated if the number of differences the learner has to consider is reduced (p.20).

It has also been suggested that these prompts can be effective because an increase in the accuracy with which the learner selects the $S^+$ during training reduces the number of errors, and thereby reduces the countereffects that errors may have (Spiker, 1959; Hively, 1962; Terrace, 1963a; Sidman & Stoddard, 1967; Touchette, 1968). This claim will be considered in detail in Chapter 6. It will be apparent that the ability to indicate the identity of the $S^+$ to the learner, and thereby to reduce the number of potential differences and to reduce the rate of errors and their countereffects, is also characteristic of the other four types of prompt that were described. However, in contrast to non-specific prompts, they can also give specific assistance in identifying the relevant feature of the $S^+$.

In summary, it has been suggested that acquisition can be facilitated by four specific mechanisms of effect, and by general mechanisms associated with the elimination of positional differences as a basis for selection and with the avoidance of errors. What empirical evidence is there to support these suggestions? Support for the effectiveness of the general mechanisms will be provided by evidence of the effectiveness of non-specific (Type 5) prompts, since these are hypothesized to operate solely by means of these general mechanisms. Several studies have shown that this type of prompt can be more effective than no-prompt training (e.g. Terrace 1963a, 1963b; Schusterman, 1966; Strand & Morris, 1988).

With reference to the specific mechanisms of effect, it is, of course, not possible to offer any direct proof that the effectiveness of a prompt is due to some particular theoretical process (p.9). However, in the present context, the suggestion will be supported to the extent that:
- there is evidence that the prompt type can be effective;
- its effectiveness cannot be attributed to any of the other putative specific mechanisms of effect;
- its effectiveness cannot be attributed wholly to the general mechanisms of effect.
Evidence of effectiveness is provided if a prompt is shown to produce better unprompted performance on the criterion task than no-prompt training (p.11). Such evidence exists for exaggerating the relevant difference (Type 1) (Lawrence, 1952; Spiker, 1959; Doran & Holland, 1979; Strand & Morris, 1988) and perceptual prompts (Type 4) (North, 1959; House & Zeaman, 1960). There is less evidence for the effectiveness of eliminating distractions (Type 2). Cheney and Stein (1974) observed the elimination of irrelevant differences (Type 2(b)) to be more effective than no-prompt training, though the difference was not statistically significant. Though both Holland and Matthews (1963) and Schreibman (1975) successfully taught the discrimination task using the elimination of irrelevant features (Type 2(a)), neither employed a satisfactory control group, and Schreibman (at least in the visual task) employed several other types of prompt in the independent variable. Several studies have successfully taught the criterion discrimination using directive prompts (Type 3) (Guralnick, 1975; Wolfe & Cuvo, 1978; Rincover, 1978; Dowler et al., 1984), but none provided an appropriate control group to enable their effectiveness to be tested. The study by Rincover (1978) does provide evidence to support the claim that spatial location is a determinant of attention (p.21). Prompts located within the relevant component were more effective than prompts located elsewhere. However, this does not provide strict evidence for the effectiveness of highlighting, since the prompts located within the relevant component may simply have been less counter-effective than those located elsewhere. A comparison with no-prompt training is required.

In considering whether the effectiveness of any of the types is explicable in terms of the alternative specific processes, it seems that the only significant issue is whether the effectiveness of perceptual prompts can be explained in terms of the process described for directive prompts. Directive prompts were hypothesized to operate by drawing the learner's attention to the prompt which then controls an attentional response to the relevant feature. This seems an unlikely explanation of the effectiveness of at least some examples of perceptual prompts. For example, in the second study by North (1959), acquisition of a bar orientation was facilitated by increasing the size of the bars. It seems implausible to suggest that the subjects first attended to the size of the bars, and that the size then controlled an attentional response to
Finally, the effectiveness of a prompt could not be attributed wholly to the general (non-specific) mechanisms of effect if it were to prove more effective than a non-specific prompt which reduced the rate of errors by the same or more. For presumably the rate of errors is dependant on the magnitude of the facilitatory effect that occurs by means of the general mechanisms. Evidence of this nature will be considered in the next section.

2.1.3: Determinants of Variation in Effect - Formal Factors

This section considers what factors relating to the form of the prompt determine variation in its effectiveness. The existing research on these issues tends to be rather confusing, particularly in its conceptual and theoretical aspects. For the sake of clarity, the issues are first discussed, theoretically and then empirically, without reference to these problematic theories and concepts. The latter are subsequently evaluated from the perspective of the initial discussion.

Theory

The framework for the initial discussion is constructed in terms of whether the factors are within and/or across the five types of prompt listed earlier, and whether their influence is on the prompt's ability to elicit the overt response (i.e. the prompt's functionality) or the necessary precursory behaviour. We consider first factors which may create variation in functionality. Formal variations within each of the five types may be expected to produce some variability in functionality. Predictions about the pattern of variability can be derived from the suggestions that were made concerning the mechanisms of effect. For example, the rationale offered for the exaggeration of the relevant difference (Type 1 prompts) has the further implication that the larger the difference on the relevant dimension, the more likely it is to be noticed. Hence, the greater the exaggeration of the relevant difference, then, generally, the more likely it is to be effective. Another example is that the effectiveness of prompts which involve the elimination of distractions (Type 2) may be expected to vary according to the number of
distractions they eliminate. With reference to formal variations across type, there is no obvious reason to expect such variations in themselves to have an effect upon functionality.

We consider next factors which may influence the prompt's ability to elicit the necessary precursory behaviour (i.e. attention to the relevant feature). With reference to across-type differences, we can expect non-specific prompts to be less effective in this respect than the other types. This is because the latter can assist the learner not only to identify the S+, but also to identify the relevant feature of the S+ (p.23).

Another such factor is whether or not the prompt introduces an irrelevant difference between the S+ and the S-. For if such a difference is introduced, then it becomes possible for the learner reliably to select the S+ on the basis of this irrelevant difference alone - that is, without attending to the relevant difference. For example, in the study by Koegel and Rincover (1976), in which a shape discrimination was prompted by colouring the S+ red and the S- green, the learner could have reliably selected the S+ simply by attending to the colour alone, and not attending to the shape of the stimuli. Indeed, this is a significant possibility in the (typical) case that the prompt-introduced difference is more noticeable than the relevant difference. Furthermore, there may, in some cases, be a significant possibility that, having once selected on this irrelevant basis, the learner will continue to do so throughout training and thereby fail to attend to the relevant feature. For since such selection will result in 100% reinforcement, the external incentive to discover the relevant difference is removed.

Since attention to the relevant feature is necessary for learning to occur (p.18), then we may predict that prompts which introduce an irrelevant difference can be less effective than those which do not introduce an irrelevant difference. Indeed, we can go further and suggest that, in some circumstances, they may be no more effective than no-prompt training or even less effective (i.e. countereffective). This is because, under no-prompt training, in contrast to training with this type of prompt, only attention to the relevant feature will ensure 100% reinforcement. Thus, the incentive to discover the relevant feature may
In other circumstances, however, such prompts may nevertheless still facilitate acquisition (i.e. be more effective than no-prompt training). For if the learner does not rely on the irrelevant difference throughout training, prompts of this type may increase the probability of the learner discovering the relevant difference relative to no-prompt training because, as suggested earlier (p.22), they can indicate the correct stimulus to the learner and thereby eliminate positional differences as the basis for making the response and reduce the occurrence of errors. They may also be more effective than no-prompt training even when the learner has relied on the irrelevant difference throughout training. For despite this reliance, the learner, having regularly selected the $S^+$, may nevertheless have incidentally noticed the relevant feature and consequently, when the prompts are withdrawn, may be able correctly to select on the basis of this feature. The probability of the learner incidentally noticing the difference in this way may be greater than the probability of the learner attending to the difference under no-prompt training.

A terminology for describing this type of prompt will be useful. When the learner makes the correct overt response on the basis of an irrelevant prompt-introduced difference, we shall say that the response has been elicited on a spurious basis (Holland, 1965). A prompt which provides such a basis (without necessarily eliciting the overt response by means of it), we shall term a potentially spurious prompt.

Variation on this factor (i.e. the introduction of an irrelevant difference) occurs both within and across types. Non-specific prompts (Type 5) necessarily do so, since this is the operational definition of the type. Type 1 prompts, which exaggerate the relevant difference, typically do not; nor do those which involve the elimination of irrelevant differences (Type 2(b)). The remaining types (i.e. those which eliminate irrelevant features (Type 2(a)), directive prompts (Type 4), and perceptual prompts (Type 4)) can all introduce an irrelevant difference, but, unlike Type 5 prompts, they can also be applied in ways which avoid this. Studies which have used directive prompts can illustrate this point. Rincover (1978) and Guralnick (1975) both used
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highlighting to teach letter discrimination. Rincover applied it only to the S+. Accordingly, the learners could have selected the S+ solely on the basis of whether the highlighting was present or absent, rather than on the basis of the letter's shape. By contrast, Guralnick applied the highlighting to the distinguishing features of both the S+ and the S-, so that the highlighting differed between the two only in respect of the relevant features (i.e. shape and position).

Although four of the types can introduce an irrelevant difference, it is unlikely that, when they do so, their effectiveness relative to no-prompt training will be reduced to an equal extent, or that their counter-effects will be equally great. For the probability of the learner relying solely on the spurious difference during training (and the probability of the learner incidentally noticing the relevant difference) presumably depends on the noticeability (p.19) of the relevant difference. In the case of non-specific prompts, the relevant difference is not made more noticeable and so the learner may be more likely to rely solely on the irrelevant difference. By contrast, the other prompts (Types 2, 3 and 4) do increase its noticeability and so we might expect them to be more effective, other things being equal.

In summary, it has been suggested that:
(1) Formal variations within each type can influence the effectiveness of the prompt in ways which can be predicted from the account given of how that type can have a facilitatory effect.
(2) Prompts which introduce an irrelevant difference (i.e. potentially spurious prompts) can, depending on the circumstances, be less effective than those which do not; no more, or even less effective, than no-prompt training; and more effective than no-prompt training.
(3) Non-specific prompts can be less effective than alternative forms. This may be because the non-specific prompt introduces an irrelevant difference, but the alternative does not. Even when both do introduce such a difference, non-specific prompts, other things being equal, may be more likely actually to function in a spurious way because they provide less assistance in identifying the relevant feature. For the same reason, even if both do function in a spurious way throughout training, the learner may be less likely incidentally to notice the relevant feature when non-specific
prompts are used. Finally, even if neither functions in a spurious way, the non-specific prompts may still be less effective - again because they provide less positive assistance in identifying the relevant feature.

The qualified nature of these claims should be noted. It is not suggested, for example, that other prompt types are always more effective, or at least as effective, as non-specific prompts (i.e. that they have 'universal' or 'overall' superiority - p.13). Effectiveness is dependant on several independently-varying factors. Variation on another of these factors in favour of non-specific prompts may outweigh their inferiority in terms of the fact that they do not offer any specific assistance in identifying the relevant feature. For example, a functional non-specific prompt is likely to be more effective than a non-functional alternative.

Evidence

To what extent are these suggestions supported by existing empirical research? Evidence relating to the first suggestion is difficult to find. With reference to the second suggestion, there is evidence that prompts which introduce an irrelevant difference can be no more, or even less, effective than no-prompt training (e.g. Schwartz et al., 1971; Koegel & Rincover, 1976). This inferiority may be attributed to the fact that the non-specific prompts used in these studies introduced an irrelevant difference, since it is most implausible to try to explain it in terms of their failure to provide specific assistance. There is also evidence (again using non-specific prompts) that prompts which introduce an irrelevant difference can be more effective than no-prompt training (Terrace, 1963a, 1963b; Schusterman, 1966; Strand & Morris, 1988 - p.23).

Direct evidence relating to the claim that such prompts can be less effective than prompts which do not introduce an irrelevant difference is more difficult to find. There are some studies which have compared non-specific prompts (which necessarily introduce an irrelevant difference - p.27) with those which exaggerate the relevant difference (Type 1) (which typically do not introduce such a difference - p.27), and have observed the latter to be more effective (Schilmoeller & Etzel, 1977; Schilmoeller et al., 1979; Richmond & Bell, 1983; Strand & Norris, 1988) However, it
is not clear from these studies that the reason for the inferiority of
the non-specific prompts was the fact that they introduced an irrelevant
difference. Other explanations are possible (e.g. that neither prompt
functioned spuriously, but the non-specific prompts were inferior because
they provided less assistance; or, in the study of Richmond and Bell,
that the non-specific prompts were less functional).

With reference to the third suggestion, the evidence cited in the
previous paragraph supports the claim in general terms, but it is not
clear which specific part of the claim is supported. That is, it is not
clear whether the non-specific prompts were inferior because the learners
tended to rely on the spurious basis for responding, or because they were
given less assistance in identifying the relevant feature. Rincover
(1978) and Wolfe and Cuvo (1978) compared non-specific prompts with
directive prompts (highlighting) (p.20). In both cases the directive
prompts were applied only to the $S^+$ and thereby introduced an irrelevant
difference. Despite this, and despite the fact that the two types of
prompt were equally functional, the directive prompts proved more
effective in both studies. This suggests that non-specific prompts can
be less effective than an alternative even when both do introduce an
irrelevant difference. This in turn suggests that inferiority can arise
from the fact that they provide less assistance.

Existing Accounts

The final part of this section examines the approaches taken by
existing research to the issues concerning the formal determinants of
variation in effect. These approaches can be somewhat confusing. The
theoretical account underlying the empirical work has not always been
made explicit. Often there is no clear distinction between the
theoretical hypotheses and the operationalized hypotheses derived from
them, and also the latter often misrepresent the former. The terminology
reflects this lack of differentiation, and is in other ways ambiguous.
These features complicate the interpretation of the empirical evidence.
In order to introduce some clarity, the theoretical and operational
hypotheses are considered separately.

The only clearly-stated and detailed theoretical account relating to
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formal determinants is based on some basic behavioural research on selective attention. This research indicates that, when animals are presented with multi-featured stimuli in an operant paradigm, they will typically select out just one feature of the compound and associate responding with that feature alone - such that, when the features of the compound are subsequently presented individually, only this feature elicits a response (Reynolds, 1961; Mackintosh, 1965; Westerbrook & Miles, 1970; Sutherland & Mackintosh, 1971). The phenomenon is often termed 'overshadowing' (Trabasso & Bower, 1968). Similar results have also been obtained when the procedure is applied to people with autism and those with severe learning disabilities (Lovass et al., 1971; Wilhelm & Lovass, 1976; Lovass et al., 1979). In this context, the phenomenon is termed 'stimulus overselectivity'.

This research has provided the basis for a theoretical account of the formal determinants (Schwartz et al., 1971; Schreibman, 1975; Koegel & Rincover, 1976; Rincover, 1978; Wolfe & Cuvo, 1978; Schreibman & Charlop, 1981). It is assumed that, in order to acquire a discrimination, the learner must attend to the relevant feature (p.19). However, it is the case with some prompts that, in order to be effective, it is necessary for the learner to attend first to a prompt which is different from the relevant feature. (It will be apparent that this applies only to directive and non-specific prompts in our classification - p.20). This form of prompt will therefore be effective only if the learner attends both to the prompt and to the relevant feature. Consequently, the form will be effective only if the learner attends to two aspects of a multi-featured stimulus. However, the research on stimulus overselectivity suggests that, at least when there is autism or a more severe learning disability, the learner is unlikely to do this. This form of prompt, then, is likely to be ineffective with these groups. This entails that it is likely to be less effective than prompts which do not require attention to more than one feature. Indeed, the basic research on selective attention suggests that it may even be less effective than no-prompt training (Koegel & Rincover, 1976). This research indicates that the greater the initial control exercised by one feature, the less likely it is that other features will gain any control (Sutherland & Holgate, 1966). Presumably, the prompt will often exercise greater initial control than any feature under the no-prompt training. Consequently, the
relevant feature may be less likely to gain any control when the prompts are used.

The essence of this argument has also been couched in terms of the transfer of stimulus control (Strand & Morris, 1988; Doran & Holland, 1979; Etzel & LeBlanc, 1979). The evidence relating to overshadowing and selective attention suggests that some learners may find it difficult to transfer stimulus control from one feature to another. Consequently, they may find it difficult to benefit from prompts which require the transfer of stimulus control from the prompt to the relevant feature (i.e. which require attention to the prompt and the relevant feature). Those prompts which establish initial control by the relevant feature, and therefore require no such transfer, may be expected to be more effective.

In evaluating this argument, there are two general points to make. The first is that the empirical evidence indicates that the argument cannot offer a comprehensive account of what formal factors determine the effectiveness of prompts, nor even of what formal factors determine the effectiveness of functional prompts. The argument implies that the problem will occur only for those who do not attend to more than one feature of a compound stimulus. A review of the basic research on stimulus overselectivity indicates that this typically applies only to those with autism or a profound learning disability (Lovaas et al., 1971; Wilhelm & Lovaas, 1976). However, there are several studies in which prompts have proved functional but ineffective or countereffective for those with a milder degree of learning disability, and even for those without any such disability (Schwartz et al., 1971; Cheney & Stain, 1974; Koegel & Rincove, 1976).

The second point to make is that the application of the problematic types of prompt (i.e. those which require attention to two features) does not always mirror the selective attention paradigm in every particular - that is, there are sometimes differences between the two. Furthermore, it can be argued that these differences may be critical in determining whether overselective attention to just one feature occurs. If this is so, then, in those applications which show these differences, this overselectivity may not occur and the prompts may prove as effective as
alternatives. We can make the a priori assumption that overselectivity to just one feature will occur whatever the situation or paradigm, only if it is the case that overselective learners are incapable of attending to more than one feature. But the basic research provides no evidence of this. Indeed, there is evidence to suggest that this is not the case—namely, the failure of overshadowing to occur in the absence of any strong initial control by one of the features (Sutherland & Holgate, 1966), and the failure of learners who were overselective in the selective attention paradigm to be overselective in other paradigms (Rincover, 1978—see below). Indeed, the notion seems intuitively improbable. If overselective learners were incapable of attending to more than one feature of a stimulus, then they would be incapable of recognizing any complex stimuli whose identification requires attention to more than one feature (e.g. human faces).

The argument that there may be critical differences between the selective attention paradigm and the application of prompts applies most clearly to directive prompts (p.20). There are two aspects of the application of these prompts which do not characterize the selective attention paradigm, but which may be determinants of whether overselectivity occurs. The first is that the prompt is intended to control an attentional response to the relevant feature by means of some connection (symbolic or spatial) between them (p.20). In the research on selective attention, the different features have no such connection with one another. It is plausible to suggest that overselectivity to just one feature may not occur when there is a connection of this kind. The second difference concerns reinforcement. In the selective attention paradigm, when the compound is presented in the initial phase, reinforcement is not dependant upon the learner attending to more than one feature. There is no incentive to attend to more than one feature. In the case of directive prompts, this is not always the case. Unless the prompt introduces an irrelevant difference between the S+ and the S− (p.26), reinforcement is dependant upon attention to the relevant feature as well as the prompt. Again, it is plausible to suggest that overselectivity to one feature may not occur when there is an incentive to attend to both the prompt and the relevant feature.

A study by Rincover (1978) provides some support for this analysis.
The participants in this study were children with autism and a severe-
to-profound learning disability. They were thus representative of that
group who are most likely to show selective attention to just one feature
of a compound stimulus, and, indeed, some of them had shown just such
overselectivity in an earlier study. In one of the training conditions a
directive prompt was used consisting of the highlighting of the relevant
feature (p. 20). Attention to two features was therefore required.
Despite this, and despite the proven tendency of the participants to show
overselectivity to one feature in the selective attention paradigm, the
prompts were effective.

So far, directive prompts have been considered. Non-specific prompts
also require attention to two features. Are there critical differences
between the application of these prompts and the selective attention
paradigm? The empirical evidence suggests that there are. Non-specific
prompts have been shown to be effective when applied to animals which
would typically show overselectivity (including the highly overselective
pigeon) (Terrace 1963a, 1963b; Schusterman, 1966). Other studies have
observed these prompts to be effective in teaching those with severe
learning disabilities (Touchette, 1968; Strand & Morris, 1988), though in
both cases it could be argued that, though the disability of the
participants was severe, it was not severe enough to involve
overselectivity to just one feature. It is not clear what the critical
differences were between the applications of these prompts and the
selective attention paradigm. In the studies by Terrace, the critical
difference may have been the prior training given to ensure that the
learner could discriminate the two values of the prompt.

Apart from the overselectivity argument and its variant in terms of
the transfer of stimulus control, there are few other theoretical
suggestions in the existing literature. Schilmoeller and Etzel (1977)
introduced what seems to have been intended as a theoretical distinction

1 More precisely, we may assume them to have been effective. The study
did not include a no-prompt training condition. However, given the
severity of the learning disability of the participants and the relative
difficulty of the task, it seems unlikely that acquisition would have
occurred without the use of prompts.
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between 'criterion-related' (CR) and 'non-criterion-related' (NCR) prompts, claiming that NCR prompts are likely to be less effective. However, their definition of the distinction is unhelpfully vague: NCR prompts are "...not directed to the solution of the task." (p.318) and "...not related to the final solution of [the] task." (p.345). Moreover, they offer no theoretical account of why NCR prompts should be less effective.

We turn now to consider the operationalization of these theoretical claims - that is, how they have been translated into claims containing only operational terms. This is an issue that requires particular consideration because the operational claims that have been made misrepresent the theoretical claims, and this is apt to cause some confusion.

Having made the theoretical claim that prompts which require attention to only one aspect are more likely to be effective, Schreibman (1975) translated this into the operational hypothesis that prompts which are located within that component of the stimulus which contains the relevant feature (the 'relevant component') will be more effective than prompts which are located outside the stimulus. The former, she maintained, require attention to only one aspect, the latter to two. She labelled these prompts 'within-stimulus prompts' (WSP) and 'extra-stimulus prompts' (ESP) respectively.

Schreibman's operational hypothesis is at once too broad and too narrow as a translation of the theoretical claim. It is too narrow...
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because it is not only prompts located outside the stimulus that require
attention to two features, but also prompts located within the stimulus
but not within the relevant component (i.e. located within an irrelevant
component). An example of this is provided by the study of Rincover
(1978) (p.21). In one of the training conditions, highlighting was
applied to an irrelevant feature of the S+ (i.e. a feature which it
shared with the S-). Although the prompt was located within the
stimulus, it would have facilitated acquisition only if the learner
attended both to it and to the relevant feature.

The hypothesis is also too broad. A distinction needs to be made
between 'component' and 'feature'. Schreibman uses the term 'component'
to refer to a spatially discrete part of the stimulus. However, that
part may contain several different features (colour, shape, orientation
etc.). Accordingly, a prompt may be located within the relevant
component (and thereby be a WSP), but it may not manipulate the relevant
feature. In this case the learner will typically be required to attend
both to the prompted feature and to the relevant feature, and the theory
of attentional restriction would predict that such a prompt would be less
effective. It is not an option for Schreibman to respond to this by
claiming that the basic unit of attention is the component and not the
feature. Evidence from the research on selective attention indicates
that learners may respond to one feature of a component but not to
another (e.g. Touchette, 1969).

An operational hypothesis that would more closely represent
Schreibman's theoretical hypothesis would be the claim that prompts which
manipulate the relevant feature are more likely to be effective than
those which manipulate some other feature. This would circumvent the
objections so far raised. It would include under the category of
problematic prompts, those which were located within the stimulus but not
within the relevant component, and those which were located within the
relevant component but not within the relevant feature. This operational
hypothesis has, in fact, been explicitly put forward by Strand and Morris
(1988) and implied by others (Schilmoeller & Etzel, 1977; Etzel &
LeBlanc, 1979). Strand and Morris offer a similar theoretical account to
Schreibman, but couch it in terms of stimulus control (p.32). They also
make use of the CR-NCR distinction, rather than the WSP-ESP distinction.
Their theoretical claim is that prompts which establish initial control by the relevant feature are more likely to be effective than those which require control to be transferred from the prompt to the relevant feature. Their operational claim is that prompts which manipulate the relevant dimension (CR) are more likely to be effective than those which manipulate some other dimension (NCR).

Again, however, the operational claim misrepresents the theoretical claim by being too broad. There are certain types of prompt which involve the manipulation of irrelevant features, but which, to be effective, do not require the learner to transfer stimulus control from the prompt to the relevant feature (to attend to two features). This is the case with prompts which involve the elimination of distractions (p.20). In eliminating irrelevant features or differences, they manipulate irrelevant features, but they do not require that the learner attend to the prompt as well as to the relevant feature. The same applies to perceptual prompts (p.21, p.24). They manipulate irrelevant features, but they do not require that the learner attends to the prompt.

It is worth noting that, like the WSP-ESP distinction, the CR-NCR terminology has been somewhat confusingly applied because of a failure to distinguish the theoretical from the operational. As noted earlier (p.35), Schilmoller and Etzel (1977), who first introduced the distinction, offer what appears to be a theoretical definition. By contrast, Strand and Morris offer an operational definition (1988, p.138):

"A criterion-related prompt is one drawn from the same dimension that the training (or criterion) discrimination will be based upon, whereas a non-criterion-related prompt is drawn from a different dimension."

Further terminological confusion was introduced by Etzel and LeBlanc (1979) who, at some points in their paper, assimilated the CR-NCR distinction to that between stimulus shaping and fading. They have been followed in this by several other researchers (e.g. Wolery & Gast, 1984; Mosk & Bucher, 1984; Schoen, 1986). However, this is incorrect. 'Stimulus shaping', as defined by Etzel and LeBlanc themselves, refers to a prompt which manipulates the topographical configuration of visual stimuli. It is therefore a CR prompt only when topographical
configuration is the relevant feature.

Finally in this section, we consider these operational claims, and the evidence concerning them, from the perspective of the theoretical approach described earlier. With reference to the WSP-ESP claim (i.e., that prompts located within the relevant component are more effective than those located outside the stimulus), only symbolic directive prompts (p.20) and non-specific prompts (p.22) can be located outside the stimulus. However, non-specific prompts cannot be placed within the relevant component— for, in this case, they may serve to highlight the relevant feature, and thereby become examples of directive prompts. Thus, if the WSP-ESP claim is applied to non-specific prompts, it becomes the claim that directive prompts are more effective than non-specific prompts. This can be considered part of the general claim that was made earlier (p.28) to the effect that non-specific prompts may be less effective than alternatives. By contrast, if the WSP-ESP claim is applied to symbolic directive prompts, it is, in general, difficult to defend. Provided that the effects of other determinants are equal, then there appears to be no reason to suppose that a symbolic prompt located outside the stimulus will be any less effective than one located inside. The only exception to this will occur when the prompt does not, in fact, function in a symbolic way. In this case, the prompt located within the relevant component may serve to highlight the relevant feature, whereas the prompt located outside will function simply as a non-specific prompt.

Several studies have sought to test the WSP-ESP operational claim and have reported the WSPs to be more effective (Schreibman, 1975; Wolfe & Cuvo, 1978; Rincover, 1978). Schreibman's study does not provide clear evidence for the claim, since the training strategy which included the WSP also included several prompts which cannot be considered WSPs by the definition given earlier. Even with the two other studies, care must be taken in drawing out their implications. They do not provide evidence to support the theoretical claim that prompts which require attention to only one feature are superior. For the WSPs in the studies were non-symbolic directive prompts (p.20) and therefore did, in fact, require attention to two features. Indeed, for this reason Rincover's study, far from supporting the claim, was used to cast doubt on it (p.33). Moreover, neither study used symbolic prompts, and so they are not relevant to the
disputed claim that symbolic prompts located outside the stimulus are less effective. Rather, they simply provide evidence that directive prompts of the highlighting type can be more effective than non-specific prompts.

The CR-NCR operational claim implies that Type 1 prompts (which manipulate the relevant difference) will be more effective than non-specific prompts (which manipulate an irrelevant difference). This corresponds to suggestions made earlier (p.28) to the effect that non-specific prompts may be less effective than alternatives. However, it also implies that Type 1 prompts will also be more effective than all the other alternative forms of prompt, since they too involve manipulating irrelevant features. However, the accounts we have given about the mechanisms of effect of these alternatives (p.20) provide no obvious theoretical reason for supposing that Type 1 prompts are intrinsically superior. It is also difficult to find any such reasons in the existing literature. Theoretical discussions of the CR-NCR distinction typically confine their account of NCR prompts to non-specific prompts.

The evidence relating to the CR-NCR distinction was discussed earlier in connection with comparisons between Type 1 and non-specific prompts (p.29). Again, although Type 1 prompts generally proved more effective, we cannot take this as evidence to support the theoretical claim that prompts which require attention to two features (require the transfer of stimulus control) are less effective. Alternative explanations of the inferiority of non-specific prompts are possible. They might have been less effective because they offered no specific assistance, or because they introduced an irrelevant difference. Moreover, it is not only non-specific prompts that require attention to two features, but also directive prompts. To support the theoretical claim, evidence of the inferiority of directive prompts in relation to Type 1 prompts would also be required. However, Guralnick (1975) observed these two types of prompt to be equally effective.

2.1.4: Determinants of Variation in Effect - Circumstantial Factors

This section is concerned with the question of which factors related to the task and to the individual learner influence the facilitatory
effect, and how they do so. Task variables are considered first, and specifically the difficulty of the discrimination. There are two dimensions of difficulty to consider. The first relates to the difficulty of determining the identity of a relevant feature - that is, the discriminability of the relevant feature. This depends on several task-related factors, including the magnitude of the relevant difference (p.25); the number of irrelevant features (p.25); the number of redundant relevant features (Zaman & House, 1963; Gold, 1972); and the degree of abstraction required to determine the identity of the relevant feature (Schwartz et al., 1971). Several researchers have suggested that the more discriminable the relevant feature is, then the more effective non-specific prompts (as we have termed them - non-criterion-related prompts as they have termed them) will be (Doran & Holland, 1979; Etzel & LeBlanc, 1979; Strand & Morris, 1988). However, it is not clear what these researchers are claiming. A distinction must be drawn between 'effective' in the sense of having a greater effect than no-prompt training, and 'effective' in the sense that the learner acquired the discrimination when the prompt was used (p.11). If it is used in the latter sense, then the claim amounts to the suggestion that a discrimination is more likely to be acquired when it is easier to acquire (i.e. more discriminable). This is a tautology of no interest.

The claim is of more substantial interest if 'effective' is used in the former sense - that is, if the claim is that the facilitatory effect of the prompt will increase as the discriminability of the stimuli increase. However, it is difficult to find in the existing research any theoretical arguments or much empirical evidence to support this latter claim. The theoretical arguments that have been advanced in this context (Doran & Holland, 1979; Etzel & LeBlanc, 1979) are not very elaborate and appear to have application only to the tautologous version of the claim. For example, Etzel and LeBlanc maintain that non-specific prompts are more likely to be effective if, after the prompt has been removed, there are no irrelevant features - since, in this case, the learner, in order to select on the basis of a difference between the stimuli would be compelled to do it on the basis of the relevant difference. However, this is only to say that acquisition is more likely when the discrimination is easier, not that the facilitatory effect of the prompts will be greater. Moreover, the empirical data cited in support of the
claim (Goetz & Etzel, 1977 (cited by Etzel & LeBlanc, 1979); Doran & Holland, 1979; Strand & Morris, 1988) support only the tautology. For example, Doran and Holland observed that criterion performance was better following the fading-in of the S- when the criterion discrimination was easier. This indicates that easier discriminations are more likely to be acquired, but, to support the claim that the facilitatory effect of prompts depends on the ease of the task, it is necessary to provide evidence of an interaction between the prompt/no-prompt variable and the ease of the discrimination. Koegel and Rincover (1976) provided evidence of just such an interaction, though in the context of the non-specific prompts being countereffective rather than facilitative. Thus on the easier discriminations, the no-prompt training and the prompts were equivalent in effectiveness; on the more difficult discriminations the prompts were less effective. How are we to explain this? Earlier in this chapter (p.27), we suggested that, even when the learner does rely on the spurious difference throughout training, a spurious prompt may still facilitate acquisition. For, despite reliance on the irrelevant difference, the learner may nevertheless have incidentally noticed the relevant difference, and consequently, when the prompts are withdrawn, may be able to select the correct stimulus on the basis of this difference. Presumably, a learner is more likely incidentally to notice a more discriminable difference. With appropriate modification, we can apply this argument to explain why the countereffects of a spurious prompt may be less when the discrimination is easier.

The second dimension of difficulty concerns the complexity of the discrimination. This is dependent upon the number of relevant features which the learner must determine in order to respond correctly, and whether or not the relationship between two or more relevant features must also be determined. Most of the existing research concerns simple discriminations in which only one feature is relevant (Ruggles & LeBlanc, 1982). However, the effectiveness of stimulus prompts also needs to be considered in relation to more complex discriminations, such as conditional discriminations (in which the presence or absence of other stimuli determines whether a stimulus is the S+ or the S-) and the acquisition of multi-dimensional concepts (in which the learner has to acquire knowledge of several relevant features, and may have to attend to different features on different occasions in order to classify different
Concerns about such applications have been raised by several researchers (Gollin & Savoy, 1968; Cheney & Stein, 1974; Rincover, 1978; Aeschliman & Higgins, 1981). In discussing spurious prompts, it was suggested (p.26) that some learners, because they can reliably identify the S+ on the basis of this irrelevant difference, may fail to search for the relevant difference, and that, as a result, they may be no more, or even less, likely to determine the relevant difference than if they had received no prompts. Some evidence to support this claim was also cited (p.29). By analogy, we could argue that, in being taught complex discriminations, some learners, if they can reliably identify the S+ on the basis of one relevant feature, might fail to search for other relevant features. Yet the straightforward application of a stimulus prompt to a complex discrimination will permit the learner to do this. Thus in a complex discrimination, even if the prompt were successful in drawing the learner's attention to a relevant feature, it might nevertheless fail to facilitate acquisition. Indeed, it might prove even less effective than no-prompt training. Evidence from studies on selective attention in animals indicates that, when multi-featured stimuli are presented, the greater the initial control exercised by any feature, the less likely it is that other features will gain any control (Sutherland & Holgate, 1966; Koegel & Rincover, 1976). When the learner is prompted, the prompt may be expected to exercise greater initial control than any feature under no-prompt training. By analogy, the other non-prompted relevant features may be less likely to gain any control when prompts are given. Further theoretical support for this suggestion is provided by the idea that, in attempting to secure 100% reinforcement, the learner may attend to a range of different features, by contrast, when a prompt is given, some evidence to support this claim was also cited (p.29). By analogy, the other non-prompted relevant features may be less likely to gain any control when prompts are given. Further theoretical support for this idea is provided by the idea that, in attempting to secure 100% reinforcement, the learner may attend to a range of different features. By contrast, when a prompt is given, the learner is prompted to attend to only one feature, the less likely it is that other features will gain any control. Indeed, it might prove even less effective than no-prompt training. Evidence from studies on selective attention in animals indicates that, when multi-featured stimuli are presented, the greater the initial control exercised by any feature, the less likely it is that other features will gain any control (Sutherland & Holgate, 1966; Koegel & Rincover, 1976). When the learner is prompted, the prompt may be expected to exercise greater initial control than any feature under no-prompt training. By analogy, the other non-prompted relevant features may be less likely to gain any control when prompts are given.
There is some evidence to support these suggestions. Gollin and Savoy (1968) taught a conditional discrimination in which the background dictated whether a particular stimulus was the S+ or the S-. A simple discrimination between two shapes presented on a common background was taught first. Then the S+ of the first task was made the S-, and the two stimuli were presented on a different common background. Once criterion had been achieved on this second task, a test of conditional discrimination was administered. Though the prompted group (fading-in of the S-) reached the criterion with fewer errors on both the first and second task, they made more errors on the test of conditional discrimination than did those who had received no-prompt training. Gollin and Savoy suggested that the prompts had focussed the learners’ attention onto the shape of the S+ at the expense of attention to the background.

Rincover (1978) provided some evidence to support the suggestion as it applies to multi-dimensional concept learning. In the study, highlighting was applied to a relevant feature of the first letter in order to teach word discriminations (p.20). This appeared to be effective (p.34) insofar as the learners were able to select the S+ even when the prompts had been withdrawn. However, subsequent tests indicated that, although the participants had also learnt about some of the unprompted features of the initial letter (i.e. these features controlled their responding), they had failed to learn anything about the other letters in the word. Consequently, they were unable to distinguish the S+ from other words which began with the same letter.

Rincover's study illustrates the problems when the concept has universal defining characteristics (i.e. features which all instances of the concept possess). The problems multiply when this is not so, and the learner must attend to different features on different occasions in order to identify different instances of the same concept. For example, if gender discrimination were taught on the basis of a single relevant feature such as the presence/absence of breasts and the participant failed to learn about other relevant features, then not only, as in the case of word discrimination, would false positives occur (men with flabby pectorals), but also false negatives would occur (flat-chested women).
We should be cautious in what conclusions we draw from these arguments and the accompanying evidence. They do indicate that a prompting strategy which directs the learner's attention to just one relevant feature, though effective for simple discriminations, may not be so for complex discriminations. However, we should not conclude that stimulus prompts have no application in the teaching of complex discriminations. In the context of more sophisticated strategies, they may prove a useful tool. For example, Schilmoeller et al. (1979) taught a conditional discrimination similar to that of Gollin and Savoy (1968). One of their prompt conditions involved the integration of the figure and the ground into a meaningful whole - for example, a circle on a background of three parallel lines became, in the prompted version, a picture of the sun and its rays. This condition produced better performance on the conditional discrimination than either the fading-in of the S- (used by Gollin and Savoy), or no-prompt training. Presumably, the integrated pictures, by depicting a meaningful relationship between the figure and the ground, succeeded in drawing the learners' attention to the two relevant stimuli and the relationship between them. An alternative method of overcoming the difficulties would be to teach the several relevant features sequentially. The risk that only the initially prompted feature would be attended in subsequent stages, could be overcome by eliminating it in subsequent stages or by ensuring that it was identical in both the S+ and the S-. For example, in a gender discrimination programme, having taught it initially in terms of the presence/absence of breasts, one could subsequently cover that part of the body, or use only flat-chested figures, in order to ensure that attention is paid to other relevant features.

We consider next variables related to the individual learner. Presumably, these can influence the functionality of the prompt. For example, the intellectual abilities of learners will determine whether or

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1 The stated purpose of the study by Schilmoeller et al. was not to overcome the difficulties associated with applying stimulus prompts to the teaching of complex discriminations, but to demonstrate the superiority of CR over NCR prompts. The study may well not have done this had they chosen a more typical form of CR prompt which was applied to only one of the relevant features.
not they are able to follow directive prompts of a symbolic nature, and presumably more able learners will generally require less of an exaggeration of the relevant difference for this to elicit the correct response. Developmental and/or idiosyncratic tendencies to attend to particular dimensions in preference to others may also influence functionality. Dowler et al. (1984) tested this idea. They hypothesized that, when prompts were applied to the individual learner's preferred dimension (preference having been assessed in a pre-task screening), they would be more effective than when they were applied to a non-preferred dimension. However, though it was in the predicted direction, the effect was not significant. Dowler et al. point out that such preferences might vary substantially according to the task. Unless such variation were predictable, attention to this variable in planning a prompting strategy would be unwarranted.

In the section on formal determinants, we considered the claim that potentially spurious prompts may be less effective (p.26). The intellectual abilities of the individual may determine whether this inferiority will apply. The more able learner may be more likely to recognise that the prompted difference is not an integral part of the stimuli but has been added to help them acquire the discrimination, and that therefore they need to determine the intrinsic (i.e. relevant) difference. They are also presumably more likely to realise that the prompt is being faded and that, for this reason too, they need to find the intrinsic difference upon which to base their selection. They may also be more likely to be motivated, not only by the extrinsic teacher-delivered reinforcement, but also by curiosity concerning the intrinsic properties of the stimuli (Balla & Zigler, 1979), and again, therefore, be more likely to notice the relevant difference.

2.2: RESPONSE PROMPTS

2.2.1: Evidence of Effectiveness

It is difficult to find studies which have tested the effectiveness of response prompts in an experimentally controlled manner. There are many studies reporting that the task was successfully acquired when response prompts were used (Billingsley & Romer, 1983; Wolery & Gast,
1984; Schoen, 1986). However, as we noted in Chapter 1 (p.11), such studies do not eliminate the possibility that the task would have been acquired even in the absence of the prompts. To demonstrate the effectiveness of a component, we need to compare the effectiveness of a strategy which contains it with one which does not contain it but is otherwise identical.

2.2.2: The Mechanisms of Effect

The discussion of this issue very much follows the lines of our earlier discussion of the mechanisms whereby stimulus prompts can facilitate choice discrimination learning (p.18). The traditional account is that response prompts can facilitate learning because they can be more effective than no prompts in ensuring the emission (and thereby the reinforcement) of the overt response (Skinner, 1968). However, the qualification made Holland (1965) is again very likely to apply: It is not sufficient for the prompt to elicit the overt response, it must also elicit the necessary precursory behaviour. The need for this refinement can be argued on theoretical grounds (see below) and on the basis of empirical studies in which response prompts have been functional (i.e. they elicited the overt response) but ineffective (e.g. Schreibman, 1975; DeHaven, 1981; Aeschleman & Higgins, 1982; Mosk & Bucher, 1984). Thus, response prompts can facilitate learning because they can elicit the overt response and the necessary precursory behaviour more readily than can no-prompt training (see p.19).

In order to elaborate on this, we need first to give an account of what constitutes the necessary precursory behaviour. In the context of choice discrimination, it has been suggested that the learner must attend to the natural features which differentiate the S+ and the S- (p.19). Choice discrimination tasks involve a specific form of learning about the stimulus component (p.16). This suggests a generalization of the choice discrimination account to cover all forms of stimulus component acquisition: The learner must attend to those natural and intrinsic features which discriminate the relevant stimulus from other stimuli in the learning environment (which in a sense constitute the S-). We can justify this claim in the same way that we justified the choice discrimination account (p.18): The only basis for reliably discriminating
the relevant stimulus when no prompts are available are those features which naturally and intrinsically distinguish it from the other stimuli in the learning environment. A reliable independent response to the stimulus will therefore occur only if the response comes under the control of those features. The response will come under their control only if the learner attends to them. Therefore, the prompt must ensure that the learner attends to these natural discriminating features (the 'relevant' features).

A couple of points need to be made about this. First, the logic of the rationale requires that the learner must attend, not merely to the stimulus, but to those features of the stimulus which discriminate it from other stimuli in the environment. The point is not clearly made in the existing research. For example, some researchers have emphasized that the prompt must ensure attention to the 'natural antecedents' (e.g. Stoddard & Gerovac, 1981; Ager, 1989), but it is not made clear whether this means attention to the relevant stimulus, or to the relevant features of the stimulus. This is not a pedantic distinction. The research on choice discrimination that we have discussed makes it clear that the learner can attend to the relevant stimulus without attending to its relevant features. A second point, which will be of importance for later discussions, concerns chained responses. Skinner (1938) analysed chained responses such that the outcome of each response acts as a conditioned reinforcer and discriminative stimulus for the next response in the chain. If this is the case, then the prompt must ensure attention to the outcome of each response. However, it is questionable whether this provides a satisfactory account of all chained responses. For example, in some chains (e.g. dancing a fixed set of steps) there is no readily identifiable external outcome which can act as a conditioned reinforcer and discriminative stimulus. Another possible analysis is to suggest that the outcome of a response may be defined in terms of visual and proprioceptive feedback about the position of the body. More promising is the suggestion that each response can itself function as the discriminative 'stimulus' for the next response in the chain. In this case, attention to the previous response in the chain constitutes the necessary precursory behaviour which the prompting strategy must ensure. This analysis can be readily accommodated within the cognitive account that will be offered, and it is supported by some empirical evidence.
The other main type of learning with which we are concerned is learning about the response component (p.16). What is the necessary precursory behaviour for this? It is difficult to find any explicit discussion of this issue in the existing research. The assumption appears to be that attention to the natural antecedent is the necessary precursory behaviour for learning about the response, as well as the stimulus (Stoddard & Gerovac, 1981; Ager, 1989). However, in Chapter 4 we shall argue from the cognitive perspective that, in order to acquire the response component, it is not sufficient simply to emit the response while attending to the relevant stimulus features. Rather, the learner must encode information about the response which permits its discrimination from other responses in the learner's repertoire. For the purposes of the present discussion, we shall translate this into the behavioural requirement that the learner must attend to those features of the response which discriminate it from alternatives in the learner's repertoire. However, this is not an accurate translation, and, as we shall see, the behavioural requirement runs into some difficulty.

In summary, then, it is suggested that, in order to be effective, response prompts must not only elicit the overt response, but must also ensure that the learner attends to those intrinsic features which discriminate the stimulus from other stimuli in the learning environment, or the response from other responses in the learner's repertoire. The initial claim about their effectiveness can now be made in a more precise form: Response prompts can facilitate acquisition because they can elicit the overt response and the necessary attentional responses to the relevant discriminating features of the stimulus and the response more readily than can no-prompt training.

We next address the question of the specific means whereby response prompts can do this. This can be done by reference to the traditional distinction between verbal, gestural and physical prompts (Schoen, 1986). Gestural prompts include models (in which the teacher actually performs the response), iconic gestures (in which the teacher mimes the response) and pointing. Models and iconic gestures can increase the relative probability of the overt response by providing a model of that response.
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for the learner to imitate. If they are functional, they will also ensure that the learner attends to the relevant features of the response, since the learner must presumably attend to those features of the model in order to imitate it. In the case that the response involves the manipulation of the natural antecedents, such prompts, if functional, should also ensure attention to the natural antecedents, since the learner must presumably attend to the antecedent in order to manipulate it. As we have noted (p.47), this is no guarantee that the learner will also attend to the relevant features of the antecedent. However, if the probability of attending to the antecedent is increased relative to no-prompt training, then it seems likely that, in some circumstances at least (though by no means all - p.29), the relative probability of attending to the relevant features of the antecedent will also be increased. Pointing can also serve to draw attention to a natural antecedent, and thereby can increase the probability of this relative to no-prompt training, and this, in turn, may, in some circumstances at least, increase the relative probability of attention to its relevant features.

Verbal and other linguistic prompts create some difficulty for the general account we have adopted. Without doubt, they can increase the relative probability of the overt response by instructing the learner on how to make it. In order to make the response, the learner will also need to attend to the natural antecedents that require manipulation and so these prompts can also increase the relative probability of this attentional response. This in itself may increase the probability of attention being paid to the relevant features of the antecedent. However, a surer way of eliciting such attention is to include in the instruction explicit reference to those features such that the learner has to attend to them in order to select the correct stimulus. Likewise, instructions about the response component should include reference to those features which discriminate it from other responses. At this point, however, the general account runs into some difficulty (p.48). For intuitively, in order for acquisition to occur, it seems unnecessary that the learner, once the instruction has been received, must then attend to the relevant features of the response as it is being performed. This implies that attention to the relevant features of a response is not necessary for learning to occur. We shall reconsider this issue in
Chapter 4.

The third category is physical prompts. Full and partial physical prompts need to be given separate consideration. (The distinction will be given fuller consideration in the next section.) Full physical prompts (in which the learner's limbs are guided through the response) obviously increase the relative probability of the overt response. Their ability to elicit the necessary attentional response is less certain - the overt response may be completed without the learner paying any attention to the stimulus or response components. However, relative to no-prompt training, it seems probable that, at least in some circumstances, they do increase its probability. Consider, for example, using physical guidance to teach someone, unfamiliar with such a task, to push a button in order to operate a machine. It seems intuitively plausible to suggest that, under these circumstances, at least some people with learning disabilities would pay attention to the button and its discriminating features and the relevant features of the manipulation required, and that at least some of them would be more likely to do this than under no-prompt training (since unfamiliarity with this type of task would render unlikely a quick and unassisted discovery of the significance of the button and how it is operated).

Partial physical prompts generally fall into one of two categories. They may involve a restriction in the number of possible or likely responses that the learner can perform. Examples include moving the learner's hand to the vicinity of the relevant stimulus, and 'shadowing' the learner's movements (Demchak, 1989). By restricting the number of options, such prompts may assist the learner's own attempts to make the appropriate overt response. Alternatively, partial physical prompts may take the form of what might be called 'automodels'. The learner's hand is moved partially through a response, the teacher then lets go and the learner is required to imitate the guided response, but to carry it to completion. These can presumably increase the relative probability of the overt response in much the same way as models performed by the teacher. If either type of partial prompt is functional, then, provided

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1 Physical prompts may also facilitate acquisition by means of partial task training. This will be considered in Chapter 6.
that the response was intentional rather than accidental (a distinction which can be drawn within the cognitive, but not the behavioural, approach), then it should also ensure attention to the natural antecedent, which in turn may (but will not necessarily) elicit attention to its relevant features. In the case of the automodel type, following the model requires attention to the relevant features of the response made in the model. In the case of restrictive prompts, as with responses following verbal instructions, it is doubtful that we should insist that the relevant features of the response must be attended as it is performed.

Skinner (1968, p.207) reached a different conclusion about physical guidance. He rejected its use on the grounds that learning with such a prompt can only occur by means of negative reinforcement, which would be a rather ineffective and unacceptable mechanism of effect. He considers the example of squeezing a child's hand around a pencil and moving it to form letters. He suggests that the child is not "in any important sense" forming the letters, and therefore there is no direct learning. Rather, any learning that takes place does so because of the aversiveness of the physical force - that is, the formation of the letters is negatively reinforced by escaping and avoiding aversive constraint. Skinner fails to relate this suggestion to his basic conceptual framework. It is not clear how, within that framework, one can make a distinction between self-executed and guided responses. In any case, even if we permit Skinner to make such a distinction, doubt can still be cast on his conclusion that no positive learning will occur when the response is guided. A theoretical and empirical case can be made for the claim that the self-executed emission of the overt response is sometimes not necessary for its acquisition, and that learning can occur by means of attending to the relevant information (see Chapter 3 and Bandura (1969), who provides evidence of learning by observation alone). As illustrated in the example given earlier (p.50), it is intuitively plausible to suppose that physical guidance may increase the probability of these attentional responses relative to no-prompt training.

The merit of this claim (that physical guidance can increase the relative probability of the necessary attentional responses and thereby facilitate acquisition) would be clearer if there existed empirical tests.
of the effectiveness of physical guidance. However, as noted earlier (p.45), it is difficult to find in the existing research any studies which have conducted controlled tests of the effectiveness of the different types of response prompt. In claiming that they can be effective, one is compelled to resort to intuitively appealing examples.

Finally, as with the use of stimulus prompts in discrimination learning (p.23), it has been claimed that response prompts can facilitate learning by reducing errors and thereby avoiding their counter-effects (Holland, 1960 and 1965; Skinner, 1968; Koegel & Egel, 1979; Billingsley & Romer, 1983; Wolery & Gast, 1984). This suggestion will be considered in more detail in Chapter 6.

2.2.3: Determinants of Variation in Effect - Formal Factors

In discussing the formal determinants of variation in effect, it is helpful to recall the framework provided for the corresponding discussion in relation to stimulus prompts (p.25). By suitable adaptation, a framework for approaching the issue is provided in terms of whether the factor is within or across the main types of response prompt, and whether its influence is upon the prompt's functionality or its ability to elicit the necessary attentional responses. There appear to be two main categories of determinant - within-type factors which influence the functionality of the prompt, and, in relation to the elicitation of the necessary attentional responses, whether the prompt is potentially spurious (a factor which varies both within and across prompt types).

There are several factors to be taken into account in considering the determinants of variation in functionality. One of these is whether the prompt is full or partial. We can consider this with reference to the complete task, or to a particular component of a task. With reference to the former, a full prompt provides assistance for all the components of the task, whereas a partial prompt provides assistance for only some of them. With reference to a particular component, a full prompt of a particular type provides the maximum assistance of that type in eliciting the overt response, whereas a partial prompt provides less than this. For example, a full pointing prompt to elicit the operation of a particular button on a panel would specify the particular button to be
pressed; a partial pointing prompt might involve pointing only in the
direction of the panel without picking out the particular button. It is
in this latter sense that the terms 'full' and 'partial prompt' are used
in this thesis. It will be clear from these examples that, particularly
in the early stages of learning, full prompts are more likely than
partial prompts to be functional. A second factor to be considered are
the temporal properties of the prompt. In teaching those with learning
disabilities, it is important that the prompt is available for a
sufficient length of time to enable them to understand and follow it (the
meaning of 'understanding' in this context will be made clear in the next
chapter). Prompts are more likely, in some circumstances at least, to be
functional if they are presented continuously until the action is
performed by the learner (e.g. the teacher continues to point to the
relevant part of the task until the learner takes hold of it); or they
are delivered slowly (e.g. a verbal instruction); or they are repeated
(e.g. an iconic gesture) (cf. Skinner, 1968). Prompts which obscure the
relevant features will clearly be of diminished functionality. For
example, a model of a fine manipulative response which obscures the
nature of the manipulations required cannot be imitated by the learner.
We also need to take into account the degree of distraction provided by
the irrelevant attributes of the prompt. Attention to these features may
prevent attention to those features which it is necessary to attend to in
order to emit the overt response. Several investigators have laid
particular emphasis on the potentially distracting effects of the
irrelevant social stimulation inherent in response prompts (Walden et
al., 1975; Burleigh & Marchlin, 1977; Adams et al., 1981; Stoddard &
Gorovac, 1981; Glendenning et al., 1983; Seay et al., 1984). In similar
vein, Falvey et al. (1980) stress the need to avoid unnecessary
elaborations in giving verbal instructions. Skinner (1968) suggests that
non-verbal prompts should be given in an exaggerated form. He does not
elaborate upon what such exaggeration would involve, nor does he offer
any justification for the suggestion. However, a rationale for the
practice will be given in Chapter 4. Finally, it should be noted that
these claims about the temporal properties, the risk of obscuring and
distracting, and the need for exaggeration do not apply to full physical
guidance. Provided that there is no resistance on the part of the
learner, such prompts will always be functional. However, as we shall
discover later in this section, these properties are important in
assessing the probability that full physical guidance will elicit the necessary attentional responses.

The other factor to be considered in this section is whether or not the prompt is potentially spurious - that is, whether it provides the learner with a basis for emitting the overt response which does not entail attending to the relevant features of the stimulus and the response (p.27). The significance of this factor in determining variation in the effectiveness of prompts has already been considered with reference to stimulus prompts (p.26). If the response can be completed without attending to the relevant features, then there is a significant risk that the learner will fail to attend to those features, and thereby fail to learn the task (or at least be delayed in achieving this objective). In consequence, they may, in some circumstances, be less effective than prompts which do not provide spurious solutions. Indeed, in some circumstances, they may be no more, or even less, effective than no-prompt training (p.26).

The earlier discussion of how response prompts can increase the relative probability of the necessary attentional responses (p.48) has clear implications for an account of how this factor (i.e. potential spuriousness) varies across and within types. Gestural prompts are always potentially spurious in respect of the stimulus component, but never so in respect of the response component. For the learner can always emit the overt response in response to a gesture without attending to the relevant features of the stimulus, but to follow it successfully must attend to the relevant features of the model/mime of the response component provided by the teacher. Full physical prompts are always potentially spurious in that they always permit the overt response to be 'performed' without attention to the relevant features of either the stimulus or the response. Partial physical prompts are always potentially spurious with respect to the stimulus for the same reason we gave with reference to gestural prompts. In the case of the 'automodel' type (p.50), attention to the relevant features of the response is necessary if the learner is to follow it. In the case of the restrictive type, it was suggested that attention to the relevant features of the response is itself unnecessary. Discussion of whether or not it provides a spurious basis for responding must be postponed to Chapter 4. The same
claim was made about the use of verbal and other linguistic prompts in respect of the response component, and again discussion must be postponed. With respect to the stimulus component, verbal prompts can provide a spurious basis for making the correct overt response. However, alone amongst response prompts, they can be used in a non-spurious way by including reference to the relevant features such that the selection of the correct stimulus by the learner is dependant on attention to them.

It is not, of course, inevitable that the learner will emit the overt response on the spurious, rather than the relevant, basis. In discussing stimulus prompts, we suggested that it depends on the relative attentional value (noticeability) of the spurious and the relevant features (p.28). The noticeability of these features is presumably dependant on the formal determinants of functionality considered earlier (p.52) - namely, the temporal properties of the prompt, the obscuring of, the distraction of attention from, and the exaggeration of the relevant features. Some examples will serve to illustrate the point. If a full physical prompt is delivered slowly, then the learner is given more time in which to attend to the relevant features of the movement, and may therefore be more likely to attend to them. Again, attention to the relevant features is less likely if, as is often the case in full physical guidance, the prompt obscures the relevant parts of the task materials. Furthermore, as noted in the discussion of stimulus prompts (p.27), even if the learner does rely on the spurious solution during training, the prompt might nevertheless still facilitate acquisition, because the probability of the learner incidentally attending to the relevant features during training might be greater than the probability of attention being paid to these features under no-prompt training. Again, the probability of the learner incidentally attending to the relevant features during training is presumably dependant on the formal factors described earlier.

Finally, we should mention another claim concerning across type factors that is sometimes made in the existing research. This is that physical prompts will be more effective because they are the most effective at eliciting the overt response and thereby at avoiding errors (Walls et al., 1979; Hourcade, 1988). This claim must be rejected because it overlooks the fact that the prompt must also elicit the
necessary precursory behaviour. Physical guidance may be the most effective way of eliciting the overt response and eliminating errors, but it may not always be the most effective means of drawing attention to the relevant features (particularly since it is always a potentially spurious prompt).

In summary, it has been suggested that:
- Formal variations within each type, except full physical guidance, can create variation in functionality, and the pattern of variation can be predicted on the basis of certain factors such as whether the prompt is full or partial, and how much opportunity it gives the learner to attend and respond to it.
- Prompts which provide a spurious basis for making the overt response (i.e. potentially spurious) can be less effective, other things being equal, than those which do not (i.e. non-spurious), and may, on occasion, be ineffective or even countereffective. The same factors which determine functionality may also determine the probability that the learner will rely on the spurious solution, and therefore the effectiveness of functional but potentially spurious prompts.

Empirical evidence relating to these suggestions is difficult to find. Some evidence in support of the second hypothesis is available from studies in which the participants were people without a learning disability. Evidence that potentially spurious prompts can be less effective than those which are not, was provided by a study of Holland (1965), in which he compared a programme of instruction in which the derivation of the correct answer was dependant on reading the whole item (i.e. the necessary precursory behaviour) with a programme in which the answer could be guessed on a spurious basis. The former programme proved more effective, even though both produced an equally high rate of correct responses (i.e. the prompts were equally functional). Evidence that potentially spurious prompts can be less effective than no-prompt training was provided by Holding and Macrae (1964) who, in teaching participants to move a knob exactly 4 inches, found that full physical guidance, though more functional, was less effective than no-prompt training.

There are also some studies which have compared the effectiveness of
full physical guidance with other types of prompt for participants who did have a learning disability. For example, Nelson et al. (1975) found physical guidance to be more effective than modelling in teaching utensil use. Close et al. (1978), in teaching the stimulus discrimination component of an assembly task, observed physical guidance to be more effective than gestural prompts. Walls et al. (1979) taught assembly tasks and found modelling and physical prompts to be of equal effectiveness, but both to be more effective than verbal prompts. Hourcade and Parette (1985) and Hourcade (1988) likewise found modelling and physical guidance to be of equal effect in teaching discrimination and assembly tasks. However, these studies fail to confirm or disconfirm the second claim. It is unclear what kind of gestural prompt was used by Close et al. (1978) and therefore it is unclear whether the study offers a comparison between potentially spurious and non-spurious prompts. Although Nelson et al. (1975) provides such a comparison, the superiority of physical guidance could have been due to its superior functionality. The same explanation applies to the superiority of physical to verbal prompts in the study by Walls et al. (1979). In the studies by Hourcade and Parette (1985) and Hourcade (1988) it is not clear that the physical guidance and models were equally functional, and the results may have been affected by floor or ceiling effects.

These studies were not intended as tests of the second claim, but as tests of claims concerning the relative effectiveness of the traditional prompt types (physical, visual and verbal). It has been argued in this section that factors which vary within each of the traditional prompt types are very likely to create significant variation in effectiveness, and a similar argument will be put forward in the next section with reference to circumstantial factors. Consequently, the effectiveness of a traditional type relative to the other types is very likely to vary according to the circumstances and the particular form of the type used in the investigation. For example, physical guidance may be more effective than modelling in some circumstances, but less effective in others; and modelling may be more effective than one form of verbal prompt, but less effective than another form, in the same circumstances. In this light, straightforward claims that one of the traditional types of prompt is more effective than another are seen to be too simplistic.
2.2.4: Determinants of Variation in Effect - Circumstantial Factors

With respect to task variables, it has been claimed that response prompts will be more effective when the sensory modality of the prompt matches that of the component being taught (Falvey et al., 1980; Billingsley & Romer, 1983; Wolery & Gast, 1984; Hourcade, 1988; Ager, 1991). The suggestion is that we should use visual prompts (models and models) for visual components; auditory prompts (verbal instructions) for auditory and verbal responses; and physical prompts for motor responses. However, it is difficult to find a clear statement of the rationale for the claim. Wolery and Gast state (1984, p.60):

"This hypothesis is based on Terrace's (1963) findings that 'abrupt stimulus dimension shifts increase error responding' (Billingsley & Romer, 1983, p.8)."

However, this appears to be a misreading of Billingsley and Romer. Although they do suggest the hypothesis, their reference to Terrace's work is not made in support of it, but in support of the suggestion that using prompts of different modalities within the same prompting strategy may be ill-advised. In any case, Terrace's findings provide dubious support for the claim under discussion. Terrace (1963b) observed that the use of a colour difference to prompt discrimination of a line orientation was more effective when the colours were gradually faded than when they were abruptly withdrawn. This suggests that performance suffers when an abrupt transfer of control from the prompt to the relevant difference is required. The use of 'cross-modal' prompts does not, in itself, involve such a transfer. The elicitation of a motor response by a verbal prompt does not involve any transfer of stimulus control, abrupt or otherwise, and, although the independent performance of the response depends on the eventual transfer of control from the prompt to the relevant feature, whether or not that transfer occurs abruptly depends on the nature of the procedure, not on the form of the prompt.

Ager (1991) bases the claim on evidence which indicates that a cross-modal transfer of a discrimination is less likely to occur than an intra-modal transfer. For example, O'Connor and Hermelin (1978) initially taught learners to discriminate between the presentation of a tactile stimulus for 6 seconds, and its presentation for 2 seconds. Subsequently,
the learners were tested on their ability to discriminate between 2 and 6 second presentations of another tactile stimulus, an auditory stimulus and a visual stimulus. Performance on the second tactile discrimination was more effective than on the visual or auditory discriminations. However, this evidence again provides dubious support for the claim under discussion. The cross-modal transfer of a discrimination is a very different operation to the following of a cross-modal prompt, and difficulties experienced with the first cannot be taken to imply difficulties with the second without further argument.

Another source of support that the proponents of the claim may have in mind is the suggestion, made in the context of stimulus overselectivity, that those with learning disabilities find it more difficult to attend to two stimuli presented in different modalities than to two stimuli presented in the same modality (Lovaas et al., 1979). However, it is unclear what empirical support there is for this suggestion, and again, before we can conclude that they will therefore find it more difficult to follow a cross-modal prompt, it must be shown that there are no critical differences between the two operations.

Hourcade (1988) tested the claim by comparing the performance of four groups which represented the possible combinations of two types of prompt (visual and physical) and two kinds of task (visual discrimination and motor). The results did not show the expected interaction - that is, the performance was not superior when the task and prompt modalities were matched. However, this may not have provided a particularly valid test of the hypothesis. No quantative data are given, so that it is not clear whether floor and ceiling effects were involved. Moreover, many of his participants had only moderate learning disabilities, and it may be that the proponents of the claim would wish to confine it to those with more severe disabilities.

Turning to individual variables, we may expect some interaction between individual and formal variables in respect of the functionality of the prompt. Clearly, those with more severe learning disabilities will be less able to follow verbal and gestural prompts. Evidence of this, if it is needed, is provided in several studies (e.g. Nelson et al., 1975; Walls et al., 1979; Mosk & Bucher, 1984). It has been
suggested that there are developmental and idiosyncratic tendencies to
attend to certain sensory modalities in preference to others (O'Connor &
Hermelin, 1978; Lovaas et al., 1979; Ager, 1983). If this is so, then
the functionality of a prompt in a given modality may depend on the
attentional preferences of the individual learner. However, the evidence
relating to the existence of clear modality preferences is mixed
(O'Connor & Hermelin, 1978; Lovaas et al., 1979). In any case, when
devising a prompting strategy for a particular learner, this factor need
not be given any special consideration since any effect it has, will be
taken into account in considering whether the learner is able to follow
verbal or gestural prompts.

Some of the other formal determinants of functionality that were
discussed earlier may interact with individual variables - namely,
whether the prompt is partial or full, its temporal properties, and the
distracting potential of its irrelevant features. Prompts which are less
than ideal in these respects are presumably more likely to be functional
the less severe the learning disability of the individual. Motivational
differences may also interact with the prompt's irrelevant features in
terms of distraction. For example, there is some evidence to suggest
that the irrelevant social aspects of response prompts may be
particularly likely to distract those who have been socially deprived
(Balla & Zigler, 1979). Also, some individuals appear to find physical
guidance aversive and consequently resist it (Nelson et al., 1975; Weeks
& Gaylord-Ross, 1981; Seay et al., 1984).

With reference to the potentially spurious nature of prompts, we may
expect individual and task variables to interact with this in ways
similar to those described in the section on stimulus prompts. Of
particular interest is the suggestion that the spurious basis for
responding may be less likely to be relied on, the more discriminable the
relevant feature is (p.41). Choice discrimination tasks typically
involve less discriminable stimuli than the discriminations required in
other tasks. Consequently we might expect the risks of potentially
spurious prompts to be less for tasks in which the stimulus component is
not readily confusable with other stimuli in the learning situation. The
risk of using these prompts is further decreased if the learner is likely
to search for the relevant feature as well as attending to the spurious
feature. This, we suggested, may be partly dependant on the intellectual abilities of the learner (p.45).

2.3: OTHER APPLICATIONS OF STIMULUS PROMPTS

This section concerns the application of stimulus prompts to the teaching of perceptuo-motor tasks other than choice discriminations. There are three applications of this nature which we do not consider in the present discussion. The first concerns the use of symbolic stimulus prompts (p.20). An important example of this type is the use of pictures to prompt various self-care, leisure and vocational tasks (e.g. Wacker & Berg, 1983, Broder & Shapiro, 1985; Sowers et al., 1985). These are not included in the present discussion because the issues raised by their application are not significantly different from those raised by the use of symbolic response prompts, and are therefore more appropriately considered in association with the latter. Stimulus prompts can also be used, like partial physical prompts, to restrict the number of possible or likely responses the learner can perform. The issues raised by this type of application do not differ significantly from those considered with reference to the corresponding type of partial physical prompt (p.50). The third exclusion concerns the use of stimulus prompts in partial task training, which will be considered in Chapter 6.

Despite their potential value, stimulus prompts of the type we are to discuss are relatively infrequently used in practice and are a much neglected topic of research (Azrin et al., 1976; Stoddard & Gerovac, 1981; Weeks & Gaylord-Ross, 1981). A description of some examples may therefore be of assistance. Several studies have applied stimulus prompts to the teaching of dressing skills. Nawas and Braun (1970) cite several early studies in which the clothing was adapted in the earlier stages of training. For example, Colwell (1966) used larger buttons in the initial stages of teaching this skill. A more recent example of this is provided by Ager (1989) who increased the size, not only of the buttons, but also of the stalks and the holes. Similarly, Weeks and Gaylord-Ross (1981) tried to teach the buckling of a belt by initially using a larger buckle. The training programme of Azrin et al. (1976) moved progressively from larger clothes of a looser fit to the person's normal clothing.
2.3.1: The Mechanisms of Effect

As with response prompts and the application of stimulus prompts to choice discrimination, it has been suggested that the prompts under consideration can facilitate learning by reducing errors during training, and thereby reducing the countereffects stemming from errors (Azrin et al., 1976; Weeks & Gaylord-Ross, 1981; Ager, 1989). This claim will be considered in more detail in Chapter 6. However, in the present context, it is worth noting that, when stimulus prompts are applied to other tasks, it may be more difficult to ensure such a low rate of errors as can be obtained when they are applied to choice discriminations. Indeed, high or significant rates of error have been reported in several studies (e.g. Weeks & Gaylord-Ross, 1981; Stoddard & Gerovac, 1981). This is not unexpected given that the range of possible responses in other tasks is typically significantly greater than in choice discrimination. We might expect particular difficulty in ensuring an absence of errors when applying stimulus prompts to the teaching of the response components. This is because such prompts typically give the learners no assistance until they have made an attempt at the response.

What of the positive mechanisms of effect? With reference to teaching the stimulus component, it has been suggested that stimulus prompts may facilitate acquisition by drawing attention to the natural antecedents of the response (Stoddard & Gerovac, 1981; Ager, 1989). Just as stimulus prompts can be used to draw attention to the correct stimulus in choice discriminations, so also they can be used to draw attention to the natural antecedents in the context of other tasks. This suggestion appears to include the idea that stimulus prompts can facilitate acquisition of the stimulus component even when the antecedent is not readily confusable with other stimuli in the presentation (i.e. even when there is not an explicit choice to be made between two or more similar stimuli). The specific ways in which stimulus prompts can do this are not systematically discussed. We shall postpone further consideration of this issue until Chapter 4 because our account relies upon the cognitive research. For the present, it will suffice to describe an example of the suggested application. Part of the programme of Stoddard and Gerovac (1981) for teaching the insertion of tokens into a slot involved the illumination of the slot at the appropriate time, and the use of a cord.
which ran from the token to the slot. Presumably, the illumination of the slot could have facilitated the direction of attention to the slot because changes in the environment (the slot being suddenly illuminated) are likely to attract attention (see Chapter 4) and/or because the illumination exaggerated the differences between the slot and its surrounding environment (see Chapter 4). The cord may have facilitated attention to the slot by acting as a directive prompt (p. 20).

In discussing response prompts, we argued (p. 47) that the necessary precursory behaviour for learning the stimulus component is attention to those features which distinguish the stimulus from other stimuli in the situation, and not simply attention to the stimulus. For those features provide the only reliable basis for discriminating the appropriate stimulus in the absence of any prompts. The same argument applies when stimulus prompts are used. Stimulus prompts will facilitate acquisition of the stimulus component only if they ensure attention to the discriminating features, and not if they merely ensure attention to the stimulus. This distinction is not made clear in the account of the previous paragraph with its reference to attending to the natural antecedents. The confusion is evident in the example described earlier from the study of Stoddard and Gerovac (1981). The illumination of the slot represents the addition of an irrelevant feature to the natural antecedent. Consequently, the learners could have attended to the slot by attending to the illumination rather than to the natural features which discriminated it from the other stimuli in the task situation.

Can stimulus prompts be used to facilitate acquisition of the response component? Presumably some of the applications in the teaching of dressing skills described earlier (p. 63), if they had any facilitatory effect at all, must have had it upon acquisition of the response component. For example, it is most implausible to suggest that the looser fitting clothing used by Azrin et al. (1976) facilitated the learner's discrimination of the stimuli. However, it is difficult to find in the existing research any explicit account of how acquisition of the response component might be facilitated by stimulus prompts. This is not to say that such an account cannot be offered. Closer consideration of the prompts used by Azrin et al. and others (e.g. Ager, 1989) suggests that the changes to the task would have ensured that a less sophisticated
approximation to the criterion response was effective in achieving the required outcome of the response (i.e. task completion). This observation suggests that we might consider the application of stimulus prompts in this way as a form of response shaping (cf. Ager, 1989). In this case we may be able to offer an account of how stimulus prompts can facilitate acquisition of the response component which parallels that offered for the more traditional form of response shaping.

In this more traditional form, the teacher reinforces a series of responses which successively approximate the criterion response (Davey, 1981). The starting point is the reinforcement of a response which is reasonably frequent in the learner’s existing repertoire, and which in some respect topographically resembles the target response. The reinforcement increases its frequency. Once it is occurring with reasonable frequency, the criterion for reinforcement is changed so that it is given only for those responses which resemble even more closely the target response. The criterion must be changed such that the closer approximation is likely to occur at least occasionally, in order that it can be reinforced and thereby increased in frequency. Eventually, reinforcement is made dependant on emission of the target response. Response shaping has been shown to be more effective than no-prompt training in the teaching of responses whose topography is novel or a novel combination of various response components (Davey, 1981). Unfortunately, the explanation of why response shaping is effective (i.e. more effective than no-prompt training) is somewhat vague. If response shaping is to be effective, then it must be the case that an increase in the frequency of an approximate response increases the relative probability of the occurrence of the next response in the series (relative to no-prompt training). Why this might be so is not explained. We shall reconsider this issue from the cognitive perspective in Chapter 4.

The suggestion is, then, that stimulus prompts can be used as a form of response shaping. They can alter the task so that a less sophisticated approximation to the criterion response can be effective in achieving the required outcome of the response. Being less sophisticated, this approximate response may be more likely to occur in the learner’s spontaneous output than the criterion response. Once it occurs, it can
be reinforced and thereby its frequency increased. On the assumption that increasing the frequency of the approximate response can increase the relative probability of the occurrence of the next response in the series (including eventually the criterion response), we may conclude that this application of stimulus prompts can be more effective than no-prompt training.

We need to know more precisely how stimulus prompts can be used to make effective a less sophisticated response (i.e. one more likely to occur in the learner's output). The issue appears to have been given little consideration in the existing research. We shall postpone further discussion of it until Chapter 4 since a critical component of our account derives from the cognitive perspective.

If this application of stimulus prompts is to be considered a form of response shaping, then the question naturally arises whether it has any advantages over the more traditional form. It certainly has a practical disadvantage in that stimulus prompts make more demands on teaching resources (see Section 2.6). However, we can also discern some advantages. First, the teacher may generally be able to implement the stimulus prompt form of response shaping with greater ease and accuracy. On many tasks the teacher will be able to perceive more readily whether the natural outcome of the response has occurred than whether an approximate response has occurred. For example, it will be easier for the teacher to perceive whether the natural outcome of pressing a button has occurred (a click, the operation of the machine etc.) than whether some approximate response has occurred (e.g. whether a certain degree of pressure has been applied to the button). In contrast to the more traditional form of response shaping, the stimulus prompt form ensures that the approximate response brings about the natural outcome of the response. Consequently, when the stimulus prompt form is used, the teacher can rely on observation of whether the natural outcome has occurred, and this will generally enable the teacher to implement the strategy with greater ease and accuracy. A second potential advantage of the stimulus prompt form also stems from the fact that, unlike the more traditional form, it enables the approximate response to achieve the natural outcome. For it is plausible to suggest that, for some learners at least, the natural outcome may be more reinforcing than the artificial
reinforcement that has to be used in the more traditional form. In Chapter 4 we shall reconsider the issue from the cognitive perspective and suggest a more central advantage that the stimulus prompt form may have over the more traditional form.

The account we have offered of the effects of this type of stimulus prompt was spurred by consideration of the various studies which have applied stimulus prompts to the teaching of dressing skills (p.61). Most of these studies used the stimulus prompts in combination with response prompts (e.g. Azrin et al., 1976; Ager, 1989). This does not preclude an explanation of any effects they may have had in terms of the account that we have offered (which requires that the probability of the occurrence of the approximate response in the learner’s spontaneous output is greater than the probability of the occurrence of the criterion response in that output). For the procedures used in the studies gave the learner the opportunity to respond spontaneously prior to the presentation of the response prompts. However, consideration of the combination of stimulus and response prompts suggests another way in which this type of stimulus prompt may have an effect on acquisition. Using stimulus prompts to render a less sophisticated response effective may increase the probability of the learner successfully following a response prompt concerning that response. For example, the probability of a learner successfully executing the response following a verbal instruction may, in some circumstances at least, be increased if the response is easier to make. Once the approximate response has occurred and been reinforced such that its frequency increases, then, by the argument described earlier, the probability of the eventual acquisition of the criterion response should be increased. Thus the combination of stimulus and response prompt may elicit the approximate response, and thereby facilitate acquisition of the criterion response, in cases where neither prompt alone would have been sufficient.

It may be objected that such a combination of stimulus and response prompts is of academic interest only, and is of little interest to the practitioner. For cannot the criterion response nearly always be elicited by the use of full physical guidance? If so, why not simply use full physical guidance rather than a combination of stimulus and response prompts which will place greater demands on teaching resources (see
Section 2.6)? The answer to this is that, although full physical
guidance may be the most reliable way of eliciting the overt response, it
may not be as effective as alternatives in eliciting the necessary
attentional responses (particularly since it is necessarily a potentially
spurious prompt - p.56, p.56). The combination of stimulus and
alternative response prompts may sometimes be more effective at eliciting
these attentional responses and thereby more effective in facilitating
acquisition.

2.3.2: Evidence of Effectiveness

It is difficult to find any evidence of effectiveness. Although
several studies have reported the acquisition of teaching targets when
this type of stimulus prompt was used (Azrin et al., 1976; Stoddard &
Gerovac, 1981; Ager, 1989) none of these made use of appropriate
experimental controls (e.g. a no-prompt training condition) and so they
do not provide clear evidence that such prompts can have a facilitatory
effect (p.11).

2.3.3: Determinants of Variation in Effect - Formal Factors

There are two main potential sources of variation to be discussed.
First, formal variations within each type of prompt may be expected to
create variation in functionality. The pattern of variation can be
predicted from the accounts given of the mechanisms of effect. For
example, if the prompts facilitate acquisition by making the relevant
part of the task materials stand out from its background, then one would
predict that those prompts which involve a greater exaggeration of the
difference between the part and its background may be more effective in
some circumstances.

The second likely source of variation is whether or not the prompt
permits completion of the task without attention being paid to the
relevant feature. For reasons given earlier (p.26), such prompts may be
less effective than those which do not permit a spurious solution. We
therefore need to consider whether, and how, each of the types described
earlier may permit spurious solutions. With reference to those prompts
whose purpose is to facilitate acquisition of the stimulus component, we
have already given an example of their potentially spurious application taken from Stoddard and Gerovac (1981) (p.63). What characterizes such an application is the introduction or exaggeration of an irrelevant feature of the stimulus component. This irrelevant feature provides a means whereby the learner may select the correct stimulus without attending to its relevant features. In the example given earlier, the learner could have picked out the slot on the basis of its illumination rather than its naturally discriminating features. In the case of prompts applied to the response component, the prompt will compel the learner to rely on a spurious solution if the effect of the task change is to alter those features of the response which discriminate it from alternatives in the learner's repertoire (p.48). For example, if a task change requires the learner to pull a part of the task materials rather than push it, then the learner cannot but complete the response in a way which does not involve attention to the discriminating feature of the criterion response (i.e. that it involves pushing).

Relevant to those prompts applied in teaching the response component is a discussion by Engelmann and Carline (1982) about what they call the problem of 'response distortion'. Unless care is exercised, they suggest, the learner may learn to perform the prompted version of the task in a way that is essentially different from that required to complete the criterion version, such that the transfer of learning to the latter will be impaired. The more 'response latitude' the prompted version permits (i.e. the greater the number of ways in which it can be completed), the greater the likelihood of response distortion. For example, the use of a large button in teaching buttoning skills permits the learner successfully to complete the task by holding the flat sides of the button between thumb and finger. This method of completing the task will not, they suggest, be successful when smaller buttons are used. With smaller buttons, one must press against the edge of the button with the thumb to align it with the hole. This is a curious example, in that it is questionable that smaller buttons cannot be fastened using a pincer grip. Nevertheless, it illustrates the point.

2.3.4: Determinants of Variation in Effect - Circumstantial Factors

This issue need not detain us. The main points do not differ
significantly from those made in connection with response prompts (p.58) and the application of stimulus prompts in teaching choice discriminations (p.39).

2.4: THE COMPARATIVE EFFECTIVENESS OF STIMULUS AND RESPONSE PROMPTS

Several investigators have suggested that stimulus prompts have a significant advantage over response prompts (Schreibman, 1975; Stoddard & Gerovac, 1981; Mosk & Bucher, 1984; Ager, 1989). The main argument in support of this claim parallels the theoretical argument in support of criterion-related (or within-stimulus) prompts over non-criterion-related (or extra-stimulus) prompts (p.31). In order to be effective, response prompts, it is argued, require the learner to attend to two features of the situation - namely, to the prompt and the natural antecedent (or rather, as we have argued (p.47), the relevant feature). However, research on selective attention and stimulus overselectivity suggests that those with more severe learning disabilities tend to pay attention to only one feature in a stimulus compound. By contrast, at least some forms of stimulus prompt require attention to only one feature. This is the case, for example, with stimulus prompts which exaggerate the relevant difference in a choice discrimination task (p.19). Hence we should expect such types of stimulus prompt to be more effective than response prompts.

There are several points to make in response to this. First, it is worth repeating that the research on stimulus overselectivity and selective attention suggests that it is only those with profound learning disabilities or autism who show the restriction of attention to just one feature of a compound (p.32). The alleged advantage of stimulus prompts would, then, apply only to learners from these populations. Second, the argument clearly implies that response prompts will be ineffective for those who show stimulus overselectivity. Even if we restrict it to those with autism or profound learning disabilities, anecdotal evidence casts doubt on the claim that response prompts can never be effective for learners from these populations. A final point is that, following the lines of a similar point made in discussing the parent argument (p.32), the use of response prompts differs in several potentially critical respects from the paradigms used in research on selective attention and
stimulus overselectivity. Indeed, the use of response prompts can differ from these paradigms in the same ways as the use of directive stimulus prompts (p.33). That is, there is typically a connection between the prompt and the relevant feature, such that attention to the former may control an attentional response to the latter; and, provided that the prompt does not permit a spurious solution, there is an incentive to attend to more than one feature. We can add a third difference. Unlike the selective attention paradigms, in which the several features are typically presented simultaneously and over the same period of time, when response prompts are used, they are often given after the natural antecedent has been present for some period of time (cf. Koegel & Rincover, 1976). Such a temporal difference could be critical in determining whether only one feature is attended. Because of these differences, we should be cautious in drawing the inference from the research on selective attention and stimulus overselectivity that those with learning disabilities will not attend to both the prompt and the relevant feature and will therefore not benefit from response prompts.

There are two other arguments to consider in favour of the superiority of stimulus prompts. First, Stoddard and Gerovac (1981, p.282) state that, when response prompts are used:

"Even when pupils do perform the task, they may do so by attending solely to cues provided by the teacher."

Although they do not elaborate on this, the suggestion appears to be that all response prompts permit spurious solutions. If this were so, then stimulus prompts would indeed have an advantage. However, the suggestion is clearly incorrect. Examples were given earlier of response prompts which do not permit spurious solutions (p.54). A second argument concerns stimulus and response prompts which do permit a spurious solution. Earlier, it was suggested that learners are more likely to rely solely on the spurious solution, the greater the distraction provided by the irrelevant features of the prompt (p.55). It is often suggested that the social stimulation inherent in response prompts is a significant source of distraction (p.53). In response to this, we can simply point out that learners are by no means always distracted by the irrelevant features of the prompt.

There is a more general point to make against these claims in favour
of the superiority of stimulus prompts. As we have discussed in this chapter, formal variations within each prompt type and circumstantial factors have a considerable influence on the effectiveness of any type of prompt. Consequently, the effectiveness of one type relative to another type will vary according to the circumstances and the particular form of the prompt type used. Thus it is likely that, in any given set of circumstances, some forms of stimulus prompt will be more effective than some forms of response prompt, but that some forms of response prompt will be more effective than some forms of stimulus prompts; and that a form of stimulus prompt may be more effective than a form of response prompt in some circumstances, but less effective in others. From this perspective, it will be appreciated that claims that stimulus prompts are more effective than response prompts are too simplistic (cf. p.57).

Empirical evidence relating to the comparative effects of stimulus and response prompts is scarce (Wolery & Gast, 1984; Schoen, 1986). Several studies have reported stimulus prompts to be more effective than pointing in teaching choice discriminations (Schreibman, 1975; Wolfe & Cuvo, 1978; Richmond & Bell, 1983). However, the variation in effectiveness can be attributed to differences other than the stimulus-response prompt difference. For example, pointing in stimulus discrimination tasks permits a spurious solution (p.54), but the stimulus prompts used in the studies by Schreibman (1975) and Richmond and Bell (1978) generally did not. The stimulus prompts used by Wolfe and Cuvo (1978) did permit a spurious solution. However, they were of the directive type, and it was argued earlier (p.28) that potentially spurious prompts which offer some specific assistance in detecting the relevant feature are more likely to be effective than non-specific prompts, such as pointing, which indicate the S+ but fail to assist the learner in determining the relevant feature within the S+. Aeschleman and Higgins (1982) compared pointing with non-specific stimulus prompts (fading-in of the S-) and observed no difference in outcome.

2.5: THE EFFECTIVENESS OF COMBINING PROMPTS

This section considers the use of different types of prompt in combination. It considers only those combinations in which two or more prompts are presented simultaneously or in immediate sequence. It is not
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concerned with the presentation of a sequence of prompts in which the learner is given several seconds to respond to some prompt in the sequence before the next is given. This kind of sequence is more appropriately considered in the chapter on procedure (Chapter 6). There are three sorts of combination to consider — of two or more response prompts, of two or more stimulus prompts, and of stimulus and response prompts.

We consider first response prompt combinations. Schloss (1986) suggests that, when it is necessary to use response prompts which are of a more intrusive form (e.g. physical guidance), then they should be accompanied by the simultaneous presentation of prompts which are less intrusive (e.g. verbal instructions). The rationale offered for this is that the less intrusive prompts may thereby gain some degree of control over the response, and that, with repetition, they may gain sufficient control eventually to elicit the response without the need for the more intrusive prompts. As the response comes under the control of the less intrusive prompts, so the learner moves closer to independent performance. The combination of less with more intrusive prompts is, then, considered by Schloss to be a way of facilitating the fading of prompts. Others have made similar claims (Doyle et al., 1988; Gast et al., 1991).

However, this is open to objection. The rationale for fading offered by Skinner (1968) implies that the acquisition of control by the natural antecedents will be facilitated by fading only if the latter involves a reduction in the degree of control exercised by the prompt (see Chapter 6). On this account, the subsequent presentation of the less intrusive prompts by themselves in Schloss' strategy would constitute effective fading only if it represented a reduction in control relative to the more intrusive prompts. Yet the effect, if any, of including the less intrusive prompts in the initial stages of training would be to increase their control. Clearly there is a risk that their control might thereby be increased to such an extent that their subsequent solo use does not constitute a significant reduction in prompt control. In this case, the strategy would be ineffective and the facilitatory effects of fading would be foregone.
Walls et al. (1979) argue for the inclusion of less intrusive prompts in the initial stages on different grounds. Like Schloss, they suggest that such combinations may enable the less intrusive prompts to gain some control over the response. However, the advantage they see in this is that, in the eventuality that independent performance was not achieved, these less intrusive prompts would be easier to provide in the learner's natural environment, and would occur naturally with more frequency, than more intrusive prompts. For example, if the person failed to acquire independent performance of shopping skills, it would nevertheless be an advantage if the appropriate behaviours were under the control of verbal prompts since carers can more easily provide such cues in a shop, and they are more likely to be provided by shop assistants and passers-by. Again, however, it should be noted that their use in the initial stages of teaching may undermine the use of these prompts during the fading stage.

Another argument in favour of combining response prompts is that the combination may be more effective in eliciting the required responses (the overt response and the necessary attentional responses) than either prompt used in isolation. This may be because the two prompts may control different parts of the required behaviours, such that either prompt on its own would elicit only some of these behaviours, but in combination they would elicit them all. Alternatively, they may both control the same part, but the effect of their combined control may be greater than the effect of each individual control (cf. p.66). Some examples can illustrate the argument. Suppose the task is to push a button to operate a machine. The verbal instruction, "Press the button", might be insufficient to elicit the required response because, although the learner can follow the instruction to push, they do not understand the meaning of button and so do not know what to push. A pointing prompt to the button might also be insufficient because, although it succeeds in indicating to the learner what part of the machine needed to be manipulated, it fails to indicate how that part should be manipulated. However, the combination of the two would be sufficient to elicit the required response - the point would indicate what part to manipulate, and the instruction would indicate how to manipulate it. Prompt combinations may be particularly useful when a specific form of prompt is necessary to elicit the overt response, but there is a significant risk that it will
function in a spurious way and fail to elicit attention to the relevant features (e.g. full physical guidance - p.67). A second prompt, used in combination with the first, could serve to elicit the attentional response. To use the same example, if physical guidance were required to ensure that the button was pressed, the learner might fail to attend to the relevant features. This failure might be remedied by the addition of a verbal instruction. Likewise, a combination of two individually less functional but non-spurious prompts, may be more effective than a single functional but potentially spurious prompt (p.67).

It should be emphasized that this strategy differs from that recommended by Schloss (1986) and Walls et al. (1979) in its formal and procedural implications. The latter concerns the least intrusive form of prompt which initially exercises little or no control, and implies the use of these forms throughout training in order that they acquire sufficient control. The present argument implies the combination of prompts which, even initially, exercise some significant degree of control. Also, it does not require the repeated presentation of the combination throughout training - rather, the combination could be faded as the natural cues gain more control. It is therefore not subject to the objection raised against the strategy proposed by Schloss and Walls et al.

There is, however, an argument against the use of prompt combinations which applies to all three of the arguments in favour that we have considered. This is based on the (by now familiar) suggestion that people with learning disabilities have difficulty in attending to more than one feature of a situation (p.31). Combinations of prompts require attention to two prompts as well as to the natural cues. If the learner is unable to attend adequately to both the prompts, then either they will ignore one of the prompts and give their full attention to the other (in which case the combination will be no more effective than the use of the attended prompt in isolation), or their attention will be divided between the two prompts and they will not attend adequately to either (in which case the combination will be less effective). Combinations should therefore be avoided (Koegel & Rincover, 1976; Ager, 1991).

Our reply to this argument will also be familiar (p.32). From the
evidence relating to selective attention and stimulus overselectivity we should not infer that they will find it difficult to attend to more than one feature in all situations. It is likely that in some cases the learner will be unable to attend adequately to both prompts (in which cases a combination will be no more effective or countereffective), but in other cases they will be able to do this (in which cases a combination may be more effective). The outcome presumably depends on the form of the combination and the circumstances of its application. The most important formal factor concerns the temporal properties of the combination. In considering the formal factors which determine the functionality of response prompts, we suggested that prompts were more likely to be functional if they were presented continuously until the action is performed, delivered slowly, or repeated (p.53). Such prompts give the learner more time and opportunity to attend and respond to the prompt. Similar remarks apply in the present context. Combinations which give more time and opportunity for the learner to attend and respond to both prompts are presumably more likely to be more effective. Depending on the circumstances, this implies the need for a presentation which is continuous, slow and/or repeated. To this we can add that a sequential presentation of two prompts may be more functional than a simultaneous one - since it is presumably easier, in some circumstances, to attend and respond to two stimuli presented one after the other, than both at the same time. An important circumstantial determinant of the effectiveness of a combination is the ability of the individual learner. More able learners will presumably be more likely to benefit from a prompt combination whose form affords less time and opportunity to respond.

Evidence relating to the effectiveness of combinations of response prompts is scarce (Schoen, 1986). Walls et al. (1979) compared the effectiveness of physical guidance, modelling, verbal instructions and a combination of all three in teaching assembly tasks. The combination showed a non-significant trend to being the most effective.

The third argument offered earlier in support of the combination of response prompts may also be used to support combinations of stimulus prompts and combinations of stimulus and response prompts. That is, the combination may be more likely to elicit the overt behaviour and the
necessary precursory behaviour because the two prompts control different aspects of the responses required, or their dual control of the same aspect is greater than the control exercised by either in isolation. With reference to combinations of stimulus and response prompts, it is worth recalling the suggestion that stimulus prompts alone may often be insufficient to elicit an unfamiliar response component (p.62). Again, this superiority may apply only in some situations. In other situations, the combination may make no difference or even be countereffective. The outcome presumably depends on the same formal and circumstantial factors discussed in relation to response prompt combinations. It should be noted that stimulus prompts are typically continuous (i.e. they will be present until the response is performed) and, as such, there will be no need for them to be presented slowly or repeated.

A number of studies have investigated the effectiveness of these combinations. Two studies have observed stimulus-response combinations to be more effective than the response prompts alone. Gold and Barclay (1973), in teaching a stimulus discrimination task, found that a combination of verbal, pointing and (non-spurious) stimulus prompts was more effective than the combination of verbal and pointing prompts alone. A similar finding was obtained by Mosk and Bucher (1984). The evidence concerning stimulus prompt combinations is mixed. Irvin and Bellamy (1977) taught a size discrimination using exaggeration of the relevant difference (a non-spurious prompt), the introduction of an irrelevant difference (a spurious prompt), or a combination of the two. The combination proved the most effective. In contrast, Schilmoeller and Etzel (1977), in teaching shape and sequence discriminations, observed that the combination of exaggerating the relevant difference and introducing an irrelevant difference was less effective than using the former alone. The variation in the effectiveness of the combination across these studies may have been due to a difference in the complexity of the tasks, those used by Schilmoeller and Etzel being very complex. For the risks of potentially spurious prompts may be greater when the stimuli are less easy to discriminate (p.41).

2.6: OTHER EFFECTS

In this section we consider the effects of prompts other than those
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relating to the acquisition of the response. Specifically, we consider their effects on the generalization and maintenance of the response; their effects on other aspects of the learner's functioning; and their practical implications (i.e. the demands made on teaching resources in terms of effort, expense and expertise). Knowledge of whether and how the various prompt types differ in these respects is important for the user of the technology in selecting a specific strategy for a given set of circumstances (p.3).

Generalization and maintenance can be dealt with briefly. There appear to be few discussions in the existing research concerning how different prompt forms might differ in their effect on these outcomes. Walls et al. (1979) suggested that less intrusive prompts should be combined with more intrusive prompts during the earlier stages of learning so that they can acquire more control over the response. The rationale for this suggestion was that, in the event that independent performance is not achieved, less intrusive prompts are more likely to occur naturally, and are easier to provide, in the learner's natural environment (p.73). This implies that generalization of the response to the natural environment may be increased if it comes under the control of less intrusive variables during training.

It has often been noted that stimulus prompts are less practical than response prompts (Close et al., 1978; Etzel & LeBlanc, 1979; Wolery & Gast, 1984; Schoen, 1986). They can make heavy demands on teaching resources in terms of the materials, time and effort required for their preparation. They may also require a degree of skill and ingenuity in their preparation and application which is not readily available in many natural settings (Etzel & LeBlanc, 1979).

However, these practical disadvantages should not be exaggerated. Their preparation does not necessarily require great expense and effort. For example, those used by Gold (1974) simply involved the painting of one surface of each component in an assembly task. Sometimes materials already available can be used so that no special preparation is required (Gold & Barclay, 1973; Azrin et al., 1976). Moreover, once prepared, the modified versions can be used in teaching different learners (Striefel & Owens, 1980). The demands on resources can also be reduced if fewer
prompted versions of the task are used. Indeed, several studies have successfully applied stimulus prompts using only one prompted version of the task (e.g. North, 1959; Spiker, 1959; Gold, 1974; Irvin & Bellamy, 1977). Moore and Goldiamond (1964) and Schusterman (1966) suggest that any reduction in effectiveness arising from a decrease in the number of versions of the task can, to some extent, be compensated for by an increase in the number of trials on each version. Another possibility would be to interperse the training trials with trials on the criterion version. This would indicate when the learner is able to complete the criterion version and may thereby render unnecessary the preparation of intermediate versions. Delaying the presentation of the prompt may serve the same function (Touchette, 1971), though there may be practical difficulties in delaying some forms of stimulus prompt. The unavailability of the required skill and ingenuity in many natural settings could, to some extent, be overcome by the development of commercially available prompted versions for the more useful community-living and academic skills (e.g. Jeffree & Skeffington, 1980). Indeed, such packages might have an advantage in this respect over response prompts. For it will be clear from Section 2.2 that response prompts, too, may often require a great deal of expertise in their selection and application.

Several researchers have suggested that, whatever their effects on acquisition, physical prompts may have undesirable effects on other aspects of the learner's functioning. For example, Falvey et al. (1980) maintained that their use stigmatizes people with learning disabilities, particularly when they are adults. Wolery and Gast (1984) criticize their unnecessary use on the grounds that we should encourage people with learning disabilities to make as much use as possible of the more sophisticated abilities required to follow verbal and gestural prompts.

Wolery and Gast also suggested that the excessive use of physical prompts may lead to 'learned helplessness' and the concomitant reduction in self-initiated responses. However, the analogy seems inappropriate. Learned helplessness refers to the passivity and failure to learn shown by animals after prior exposure to a series of inescapable shocks (Maier & Seligman, 1976) and by humans after prolonged failure on insolvable tasks (Thomas, 1979). The use of physical prompts typically ensures a
series of successes, not failures or aversive stimuli. Nevertheless, an excessive use of full physical prompts may lead to, or maintain, passivity for other reasons. For it does not give the learner the experience of successfully using their own abilities and internal resources to determine and make the correct response. Without this experience, the learner may fail to acquire or improve this invaluable general ability. The failure to acquire this ability may, in turn, impair the development of the concept of oneself as an agent operating upon the external world (Kopp, 1982). Even in those with a developed sense of self, an excessive use of full physical prompts may induce passivity. For it may induce a perception of a lack of ability, and a consequent lack of confidence in applying them. In this context, it is interesting to note the study of personality variables in people with a learning disability, which suggests that many of them show an overdependency on external assistance, a fear of failure, and a lack of self-confidence (Balla & Zigler, 1979). An excessive use of full physical prompts may strengthen those characteristics.
CHAPTER 3: A COGNITIVE ACCOUNT OF SKILL ACQUISITION

This chapter describes a basic cognitive account of skill acquisition in terms of which the issues concerning prompts will be re-examined in subsequent chapters. The account derives from the information processing approach and its subsequent development within cognitive psychology. The aim is not to give a comprehensive account, but to describe only what is necessary for understanding its application to prompt use. The account is described first (3.1), and subsequently its relationship to other frameworks (3.2) and its basic implications for the use of prompts (3.3) are considered.

3.1: A DESCRIPTION OF THE FRAMEWORK

At the most general level, the cognitive approach offers an explanation of learned responses in terms of the learner encoding information about the required response, storing that information, and subsequently retrieving it and using it as the basis for responding. The present chapter considers three aspects of this - the nature of the information that is encoded, the processes involved in the application of retrieved information, and the effects of practice. The processes involved in retrieval itself and some other aspects related to encoding are considered in Chapter 7.

The Nature of the Encoded Information

Again at the most general level, the nature of the encoded information needs to be such that, when it is retrieved, then, together with any information that may be required about the current situation, it will provide the learner with sufficient information to make the learned response without the need for any external informational assistance. However, we need to specify its nature more precisely. Our primary concern is with learning which external stimulus to respond to, and what overt movements to make in response to that stimulus - that is, with perceptive-motor learning (p.16). The encoded information for a
perceptuo-motor skill has been termed an 'action programme' (Newell, 1981). The informational content of such programmes has been discussed by several researchers who have applied the information processing approach and its derivatives in giving a normative account of this type of skill (Schmidt, 1976; Summers, 1981; Newell, 1981; Annett, 1989). According to these accounts, action programmes contain an ordered sequence of steps. Each step specifies a goal to be achieved, and what response must be made in respect to what stimulus in order to achieve that goal. Achievement of the goal serves as a cue to progress to the next step, and such progress typically does not occur until it has been achieved. The goals are defined in terms of some alteration in the position of the body (typically, the limbs or the sensors) relative to the environment, and/or some change or event in the environment. The responses are defined in terms of movements of some part of the body, and the stimuli refer to items in the environment. For example, the action programme for pressing the 'play' button to operate a cassette player might contain the following steps:

<table>
<thead>
<tr>
<th>GOAL (to be achieved by)</th>
<th>RESPONSE (relative to)</th>
<th>STIMULUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Visual fixation on play button</td>
<td>Scanning movements of eyes</td>
<td>Cassette player</td>
</tr>
<tr>
<td>2. Forefinger in contact with play button</td>
<td>Outstretching of forefinger and reaching with arm</td>
<td>Play button</td>
</tr>
<tr>
<td>3. Button clicks and stays down, machine operates</td>
<td>Pressing down with finger</td>
<td>Play button</td>
</tr>
</tbody>
</table>

The stimuli, responses and goals are represented in the action programme by concepts (Lindsay & Norman, 1977). An item will be represented by a given concept if the learner perceives the item to possess those characteristics which define membership of the class represented by that concept. Concepts vary in their generality. More particular concepts include more defining characteristics and the corresponding class has a smaller membership. More general concepts
include fewer defining characteristics and the class has a larger membership. We shall use the term 'particular concept' to refer to a concept which represents a class of one.

In order to maximize the usefulness of the action programme, the concepts employed should be at a certain level of generality on the particular-general dimension. First, they should be particular enough to enable the learner to discriminate the item from possible alternatives. For, unless this is the case, then the response may be determined by these incorrect alternatives, such that an erroneous response is emitted. In the case of the stimuli, the learner needs to be able to discriminate the relevant stimulus from other stimuli which may occur in the situations in which the skill is to be exercised. A learner who cannot distinguish the play button from the other buttons on a cassette player is presumably likely often to direct the specified response to the incorrect stimuli. Likewise, the response needs to be discriminated from alternatives within the learner's repertoire, and the learner needs to be able to discriminate the required goal from other possible outcomes of the response. The items, then, need to be encoded in terms of concepts whose defining characteristics are the 'relevant features' of the items as described in the previous chapter (p.18, p.47).

Second, with a qualification to be discussed later, and subject to the restriction that they should permit the learner to discriminate the item from possible alternatives, it is desirable that the concepts are as general as possible (Schmidt, 1976; Summers, 1981; Newell, 1981; Annett, 1989). For, subject to these qualifications, the more general the concept, the larger will be the membership of the denoted class and therefore the greater will be the range of situations to which the skill can be transferred. For example, in the case of the operation of a play button described earlier, if the stimuli and responses are represented in terms of fairly general concepts rather than concepts which specify features of the stimuli and responses particular to the cassette player used during training, then the skill acquired on the basis of experience with that particular player can be successfully transferred to the operation of players which differ in respect of the particular features of the button and the pushing movement involved in the initial training.
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People with a learning disability presumably will sometimes find it difficult to achieve the optimum level of generality because of the less sophisticated nature of their conceptual system. We need, therefore, to consider the implications of not achieving the optimum. These depend on the type of concept and the type of task. In the case of the stimuli and the goals, the inclusion of particular concepts in the action programme will restrict the skill to a particular set of equipment or a particular situation. However, the acquisition of such a restricted skill may still be of significant use for the learner. For example, it is useful to be able to button one's own coat, even though one cannot button anything else because one's concept of button is a particular one restricted to those on the coat. However, this will not always be the case. For some tasks, some degree of generality in the concepts related to the stimuli and goals is essential. For example, in learning to walk across roads in safety, such a skill is of virtually no use if its application is restricted to the appearance of a particular car. In the case of responses, the inclusion of a particular concept in the action programme will restrict the skill to those circumstances in which an identical movement will have the desired effect. This will render the programme of little use for the great majority of tasks in which repetition of an identical movement will rarely have the desired effect. Consider, again, the example of operating the cassette player. The particular properties of the movement required to bring the forefinger in contact with the play button depend on the initial relative positions of the button and the finger. These positions will vary greatly, and consequently an identical movement (i.e. one with the same particular properties) will have the desired effect on relatively few occasions. There are, of course, tasks in which the identical movement will typically have the desired effect. Again the task of operating the cassette player provides an example - namely, pressing down the button. However, it should be noted that an identical movement is not necessary to operate the button, and that the effectiveness of the particular movement will be confined to equipment for which that particular movement is effective. Even on such tasks, then, the inclusion of a particular concept in the action programme is unnecessary and undesirable.

In summary, then, it has been suggested that the concepts employed in the action programme must enable the learner to discriminate the relevant
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item from possible alternatives. It has also been suggested that, with respect to certain tasks, some level of generality is essential and that, for all tasks, it is desirable that, subject to certain qualifications, the concepts are as general as possible. The implications of these suggestions for the use of prompts will be discussed in the next chapter. For convenience, we shall refer to the need for the concepts to be appropriately discriminated and appropriately general as the need for appropriate classification.

The suggestion that the concepts should be as general as possible was subject to two qualifications. The first was that the generality should be restricted by the need to maintain discriminability. We now consider the second qualification. A person without a learning disability who has learnt how to operate a particular cassette player can typically transfer the skill and successfully operate many different types of player without the need for further learning or assistance. This suggests an action programme in which the concepts are fairly general. However, such a learner will typically be able to operate a player with which they are familiar more rapidly and efficiently than one with which they are unfamiliar. It is difficult to explain this if both operations are the product of the same action programme. A plausible alternative is that initially a general action programme is used in completing the earlier operations of the original player and in operating any unfamiliar players. However, with repeated experience of a particular player, a more particular programme is developed which permits the abbreviation or elimination of certain steps in the programme, and thereby enables a more rapid and efficient exercise of the skill. For example, the more general programme might contain the instructions to visually scan the player for the play button. Repeated experience with a particular player could produce a programme which gave more particular instructions about where to look.

Some further discussion concerning the encoding of goals is appropriate. What advantages accrue to this? Our answer relates to the earlier discussion of generality (p.82). The encoding of goals is of greatest benefit for those tasks in which an identical response will rarely be effective. Consider, for example, learning to steer a car. Any particular response (e.g. turning the wheel clockwise through 60
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degrees) will suffice for only a limited number of bends. If the learner were to encode only the stimuli and the responses, then they would have to establish a different action programme (put another way, a different stimulus-response association) for each different angle that bends and corners may potentially take. Clearly this would be an onerous task, and it would be a long time before the learner could be trusted to steer the car without assistance. It is far more efficient and adaptive for the learner to encode the general goal (to keep the wheels between the kerb and the middle of the road) and to guide the response in each situation according to that goal. Even in those rare tasks in which an identical response will always be effective, there will often be great advantage in encoding the goals. This is because it will presumably often be difficult for the learner to repeat an identical movement on each occasion it is required. In some tasks, a high degree of precision is required, and slight variations in the movements will induce a significant rate of failure. Consequently, the learner who is trying to repeat identical movements in completing such a task may experience a significant rate of failure. Without knowledge of the goal and, therefore, without any criterion to judge whether or not the response had been successful, the learner would presumably progress to the next step even when the initial step had not been successfully completed. By contrast, if the goal has been encoded, the learner will recognise failures and will thereby be prompted to correct and repeat the response until success is achieved. This argument in favour of the encoding of goals also applies to tasks in which a different particular response is required on different occasions. If such tasks were learnt by means of a series of stimulus-response associations covering each potential situation, the learner would have no immediate criterion for judging that an error had been made and therefore immediate feedback would not cue a corrective response. Again, this would presumably lead to a failure to correct errors, or at least a failure to correct them in good time. Who would feel safe in a car steered by someone who never (or only belatedly) amended their initial rotation of the steering wheel in tackling corners?

The Application of the Retrieved Information

As well as the nature of the encoded information, we wish to consider some of the processes involved in the application of retrieved
information in order to produce a response. There are two general points to be discussed. First, the retrieval and application of encoded information is presumably dependant upon the occurrence of cues, either internal or external, which indicate that making a particular response is appropriate and desirable in the circumstances and that the relevant information therefore needs to be retrieved and applied. For example, implementation of the skill of operating a cassette player is dependant on the occurrence of cues indicating its appropriateness and desirability - such as sight of the player (an environmental cue) or feeling bored and wanting something to do to pass the time (an internal cue). An important complement to learning a response (though one beyond the scope of this thesis) is its control by cues of this nature.

The second point specifically concerns perceptuo-motor skills. As we have already noted (p.83), the majority of skills require the use of related but different movements on different occasions of their application. Identical movements will be successful on some occasions, unsuccessful on others. The precise parameters of the movement required for success on a particular occasion depend upon the values taken by various somatic and environmental variables on that particular occasion, and especially on the relative positions of the relevant stimuli and body parts. For example, the precise parameters of the response required in picking up and drinking from a cup on a particular occasion depend upon such factors as the initial position of the cup handle relative to the hand. Clearly, then, in order to implement the skill effectively, the learner requires information about the values taken by these variables on each particular occasion of the skill's application. Such information is not stored in the action programme. Rather, the learner must derive it from the particular circumstances of the skill's application. The exercise of the majority of perceptuo-motor skills can thus be viewed as the product of two sources of information - the learned component contained in the action programme, and perception of the particular circumstances of application. Information from the second source is used to translate the action programme into the particular response required by the particular circumstances (Annett, 1989).
The Effects of Practice

We noted earlier (p.84) that repeated practice with a particular set of task materials typically results in a faster and more efficient implementation of the skill. This was attributed in part to the development of a more specific action programme. There is another, more important, reason. Within the information processing approach, a distinction has been drawn between 'controlled' and 'automatic' processes (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977; Posner & Snyder, 1975; Neely, 1977). Controlled processes require attention for their completion. Attention is of limited capacity such that when a significant amount of attention is allocated to one process, there may be insufficient remaining to carry out other processes at the same time (Broadbent, 1958; Kahneman, 1973; Norman & Bobrow, 1975). Accordingly, the execution of one controlled process may prevent, delay, or interfere with, the execution of another such process at the same time (or in close temporal proximity, since shifts in attention from one process to another take time (Glass & Holyoak, 1986). Inasmuch as they require attention for their completion, the contents of these processes will typically emerge into conscious awareness. By contrast, automatic processes can be completed without the need for any attention and without the person being aware of them. Except when they make use of the same input or output channels, their completion does not interfere with the completion of other processes, and more of them can be completed simultaneously ('parallel processing'). A process can be automatic only if it has been repeated many times so that it is well learnt. The processing of new information must be controlled. Automatic and controlled processes should be viewed as the opposite ends of a continuum. The more a process is repeated, the less attention it requires for its completion, the less awareness it creates, and the closer it moves to the automatic end of the continuum. If these notions are applied to the case of deliberate learning, then we can say that the initial encoding of the relevant information will need to be controlled, as will the initial instances of its retrieval and application. With practice, the degree of control required will gradually be reduced and the learner will be able to retrieve and apply the stored information with minimal attention (Fitts & Posner, 1967; Summers, 1981). This improves efficiency in the sense that it enables the learner to do other things at the same time as exercising...
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the skill (since, being automatic, it does not interfere with other processes). Furthermore, once the temporal restraints imposed by the need for the relatively slow controlled processes are reduced, the increased automaticity of the skill's application permits an increase in the speed with which it can be completed (Annett, 1989).

Practice has a role to play not only in increasing the speed and efficiency with which an acquired skill is executed, but also in the prior stage of establishing the initial ability to execute the skill successfully. For the encoding and retrieval of the required information are not sufficient for the successful execution of a skill. There are several other conditions that need to be met. Practice can help satisfy some of these. For example, a lack of muscular power may prevent the skill's execution, and practice can help increase that power to the required level. A failure to execute a skill may also be due to an inability to perform the response with the necessary degree of precision. For example, someone learning to juggle may know what trajectory and height are required in throwing each ball, but have difficulty in reliably throwing the balls in conformity with these parameters. Again, practice can remedy the problem.

A third obstacle to the execution of a skill may arise if the simultaneous attentional demands it makes are too great. Many skills require the performance of several responses simultaneously or in close temporal proximity. As described earlier, the process of executing an unlearnt response will require a significant degree of attention for its completion in the initial stages, and this reduces the attention available for the execution of other controlled responses. Consequently, when several unlearnt responses have to be completed simultaneously or in close proximity, the execution of one may interfere with the execution of the others. The effect of this may be that the learner is unable reliably to execute the skill. However, as was also described earlier, practice can reduce the amount of attention required for the execution of a response. Consequently, with practice, the amount of attention required for each response will be reduced and the amount available for each response will increase. The effect of this should be to reduce any mutual interference and permit the successful execution of the skill.
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Following this line of argument, we can suggest that practice may also facilitate the initial encoding and subsequent retrieval of the required information. For these processes, too, require attention for their completion. Excessive attentional demands made by the need to execute simultaneous responses may therefore prevent the learner from encoding or retrieving the information about a response. Practice may overcome this problem by reducing the attentional demands made by the completion of these simultaneous responses.

3.2: ITS RELATIONSHIP TO OTHER FRAMEWORKS

Further understanding of the conceptual approach described in the previous section may be gained by considering some points of similarity with alternative conceptual approaches. Two of these alternatives merit particular consideration - the mentalistic approach (Hyland, 1981) and the behavioural approach. There is some correspondence between the mentalistic concept of understanding and the information processing concept of encoding, and between the mentalistic concept of remembering and recall and the concept of retrieval. Encoding and understanding have a particularly close relationship in the context of learning in that they appear to denote the same set of events. For example, when a learner has accurately encoded the information relevant to a particular skill, then we would also say that the learner had accurately understood how to perform the task. The relationship between remembering and retrieving is less close. Retrieval denotes some events that would not be described as remembering. Thus, when the information is automatically retrieved and the learner is therefore not consciously aware of it, we would not say that the learner had remembered that information. For example, we would not normally speak of a person 'remembering' how to drink from a cup. However, remembering does appear to denote the same set of events as retrieving when the latter is a controlled process involving conscious awareness. Thus 'remembering' could appropriately be used to describe the retrieval of encoded information in the initial stages of learning. Within the mentalistic approach 'recall' seems to be used synonymously with 'remember'. In some research which adopts the information processing approach, 'recall' appears to be used in a more restricted way than 'retrieval' to denote consciously attended retrieval. The use of 'recall' in the two approaches thus appears to coincide. The term
'recall' will therefore be used in subsequent chapters to refer to the process of retrieval during learning.

One point of similarity between the alternative approach and the behavioural approach employed by existing prompt research is that both make use of the concept of attention. For both, attention to the relevant items is critical for learning. However, the two uses of the term need to be distinguished. 'Attention' as it is used in existing research is typically defined in a strict behavioural sense - it denotes selectively looking at, or otherwise selectively perceiving, some particular aspect of the environment. When it is used within the cognitive approach, though it encompasses this class of behaviours, it has a broader frame of reference. For example, it is assumed to be involved, not only in the initial encoding, but also in the processes of retrieving and acting upon the stored information. Moreover, it can be considered in quantitative terms (i.e. how much attention is paid) rather than the qualitative terms of the behavioural approach (i.e. whether or not attention is paid).

It is worth noting that even in the existing behavioural work, 'attention' is used in a more cognitive way than the strict behavioural definition would allow. Examples of this may be seen in the research on the use of stimulus prompts in discrimination learning. Some stimulus features occupy the same space and so, when the learner looks at one of these ('look at' being used in a strict behavioural sense to refer to the overt response), they must also look at the others. The definition therefore does not permit the possibility that the learner could attend to (and thereby come under the control of) one of these features but not the others. However, researchers within the behavioural approach clearly allow for this possibility and they are supported in this by the empirical evidence (p.30, p.36).

Another point of similarity with the behavioural approach relates to the discussion of the need for appropriate discrimination and generalization. As we argued earlier (p.82), items encoded in the action programme need to be conceptualized in terms which discriminate the item from possible alternatives but which, subject to this discriminatory restriction, are as general as possible. The need for the learner to be
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able to discriminate the relevant stimuli is well appreciated within the
behavioural tradition. There appears to be less recognition of the
importance of discriminating responses. This is evident, for example, in
the lack of discussion concerning the necessary precursory behaviour for
learning about the response component (p.48). The discrimination of
goals is likewise somewhat neglected, though Skinner (1953) does discuss
the need in the context of what he called 'continuous repertoires'. This
term refers to a set of responses which are very similar, but
nevertheless lead to different outcomes. For example, slight differences
in vocal responses can nevertheless produce different spoken words. The
ability to discriminate these outcomes is necessary if the learner is to
acquire the repertoire. For the different outcomes will differentially
reinforce the different responses only if the learner can discriminate
those outcomes\(^1\). The importance of the generalization of an acquired
skill is well appreciated within the behavioural approach (e.g. Stokes &
Baer, 1977). However, this appreciation has tended to focus on the
emission of a specific response despite task and circumstantial changes
(i.e. stimulus generalization), and less emphasis is placed on the
importance of being able to use related, but different, responses to
accommodate such changes (i.e. response generalization). We shall
discuss the latter in more detail in the next chapter.

The need for discrimination and generalization have been brought
together, and an attempt made to systematize the diverse comments made on
these points in the behavioural literature, in a general account which
uses the notion of stimulus and response classes (Horner et al., 1982).
For each skill we can define a response class in terms of those responses
which produce the same outcome and which share some common topographical
characteristics; and a stimulus class in terms of those stimuli which are
the appropriate antecedents for the response and which share some
stimulus characteristics in common. In teaching the skill, the purpose
should be to ensure the establishment of a general stimulus class-
response class association such that, when presented with any member of

\(^1\) Note that in Skinner's analysis the importance of discriminating the
outcomes concerns the effects of reinforcement, not the direction of
behaviour towards the achievement of the goal (which is why it is
important from the cognitive perspective - p.84).
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the stimulus class, the learner is able to use the appropriate member of the response class.

In view of this account, we need to reconsider our earlier claim that encoding information about the goals of the response is important because it promotes greater generalization (p. 84). The claim was based partly on alleged difficulties in accounting for skill acquisition purely in terms of stimulus-response associations. It might at first seem as if this account in terms of general stimulus class-response class associations avoids these difficulties, and thereby undermines the argument that information about the goals needs to be encoded. However, this is not the case. For the account provides no explanation of how the learner can select from the response class that member which is required to achieve the desired outcome in the particular circumstances in which the skill is being applied. Encoding information about the goals provides the basis for making this selection.

Criticism of the details of the behavioural account must not be understood as an attempt to undermine the value of the general behavioural approach. The alternative approach described here is not intended to replace other approaches such as the mentalistic or the behavioural. Rather, it is intended to supplement them. There are no correct or incorrect conceptual frameworks, only useful or useless ones (Hyland, 1981). We should therefore make whatever use we can of whatever frameworks are available (p. 6).

3.3: ITS BASIC IMPLICATIONS FOR THE USE OF PROMPTS

Within this alternative approach, then, learned responses are seen as the product of the encoding and subsequent retrieval of information concerning those responses. Unassisted performance of a learned response is therefore dependant on the learner having accurately encoded the information, and then being able to retrieve it without assistance. This, in turn, implies that, in devising a prompting strategy, the general aims should be:

- initially to ensure that the required information is accurately encoded
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- subsequently to ensure that the learner is able to retrieve that information without assistance

There is a close correspondence between these aims and the division of the issues we have made into those concerning prompt types and those concerning procedures. In reconsidering the issues concerning prompt types from the alternative approach (Chapter 4), we shall primarily be concerned with the need to ensure accurate encoding. In reconsidering the issues concerning procedures (Chapter 7), we shall primarily be concerned with the need to ensure unassisted retrieval.
CHAPTER 4: PROMPT TYPES - A THEORETICAL RECONSIDERATION

The purpose of this chapter is to discuss the issues related to prompt types within the terms of the cognitive account described in the previous chapter. As we noted in that chapter (p.93), in reconsidering these issues, we shall be primarily concerned with the need to ensure accurate encoding of the relevant information. The discussion is selective in scope. The main focus is upon the implications relating to the mechanisms of effect (4.1) and the formal determinants of variation in effect (4.2). These are the implications of most relevance to the empirical investigations reported in Chapter 5. In discussing the two main areas of interest, we shall give an account of them within the terms of the cognitive approach, and discuss how this account relates to the behavioural account given in Chapter 2. We shall also consider what implications the account has in terms of refining, or adding to, existing practices.

4.1: THE MECHANISMS OF EFFECT

A useful starting point for the discussion of this issue is a summary of the behavioural account. Skinner's original claim was that the emission and reinforcement of the overt response is necessary and sufficient for acquisition, and that prompts can be effective because they can elicit the overt response more readily than no-prompt training (p.18, p.46). According to the refinement proposed by Holland (1965), prompts will be effective only if they elicit the necessary precursory behaviours as well as the overt response. In the case of choice discrimination learning, the necessary precursory behaviour is attention to those features which naturally discriminate the stimuli (p.18). In respect of learning in contexts other than choice discrimination, the assumption in the existing research appears to be that the necessary precursory behaviour is simply attention to the natural antecedents (p.46, p.63).

We raised some doubts about the latter assumption. First, we pointed
out that the logic of the argument about what constitutes the necessary precursory behaviour for choice discrimination learning implies that, in other contexts too, the prompt should draw attention not simply to the stimulus (the natural antecedent), but to those features of the stimulus which discriminate it from the other stimuli in the task situation (p.46, p.63). Second, we questioned whether attention to the antecedent constitutes the necessary precursory behaviour for learning about the response component (p.48). We tentatively suggested that, in order to acquire the response component, the learner must attend to those features of the movement which discriminate it from other movements in the learner's repertoire (p.48). However, this ran into some difficulties. For example, it seems intuitively incorrect to maintain that, in order to learn the response component, the learner must attend to the discriminating features of the response they are making when following a verbal instruction.

The cognitive account of how, in general terms, prompts can be effective can be given in a way which is formally similar to the behavioural account: Encoding of the relevant information is necessary for learning to occur, and prompts can facilitate acquisition because they can be more effective than no-prompt training in ensuring that this takes place. From this perspective, we can see that, in order to learn about the response component, it is not sufficient simply to attend to, or encode information about, the stimulus. Rather, the learner must encode information about what response is required and this entails classifying it in a way that discriminates it from similar responses in the learner's repertoire (p.82). The cognitive account also supports the intuition that it is not always necessary for the learner to attend to the discriminating features of the movement as it is being made. For, in order to follow a verbal instruction, for example, the learner must first encode information about what response is required before making that response. It is therefore not necessary for the learner to then attend to the discriminating features of the movement as they are making it.

From the cognitive perspective, there are two main ways in which prompts can facilitate encoding of the relevant information. In the first way, the prompt itself contains relevant information and the learner derives this information by attending to the prompt. We refer to
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these prompts as informational prompts. Examples of this type include the majority of verbal prompts, full physical guidance, models and iconic gestures. The second way consists in the prompt increasing the 'attentional value' of some feature of component of the task. The 'attentional value' of an item refers to the probability of that item being attended, and specifically to that component of the probability which is determined by stimulus factors (as opposed to individual and situational factors). The prompt itself does not contain the relevant information, but it serves to draw attention to some relevant element in the task. We refer to these as attentional prompts. Examples include most stimulus prompts and pointing.

Not all prompts fall into one of these two main categories. Other categories include those which restrict the number of responses the learner can make, such as some forms of partial physical prompt (p.50) and some forms of stimulus prompt (p.61). There are also what we might term 'secondary prompts'. These contain information about, or draw attention to, other, primary, prompts which in turn contain relevant information or draw attention to it. Instructions to look at or listen to a verbal or gestural prompt provide an example of this type.

We consider next the implications of this alternative general account for the application of prompts, and specifically those which suggest improvements to existing practices and those which suggest relatively novel practices. The latter include the use of prompts to enhance the discriminating features of a response; to provide or enhance information about the goals of a response; and to facilitate generalization. The existing practices illuminated by the cognitive account include the use of stimulus prompts as a form of response shaping (p.64), and the use of prompts to enhance the attentional value of the discriminating features of the stimulus (p.19, p.62).

Enhancing the Discriminating Features of a Response

The cognitive account emphasizes the importance of the learner classifying the response at a level which is appropriately discriminatory and appropriately general (p.82). It further suggests that prompts can facilitate this process by either the informational or the attentional
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mechanism. It is common in existing practice for prompting strategies to include informational prompts which contain relevant information about the response component. However, it is much less common for attentional prompts to be used to increase the attentional value of the discriminating features of a response. Indeed, even when this does occur, the rationale for it is not made clear, or the enhancement of these features is incidental to some other purpose.

There are various specific ways in which the attentional value of the response's relevant features can be increased. These can be derived from the basic cognitive research on attention (e.g. Trabasso & Bower, 1968). We have already encountered some of them but a more extended list may be useful:

Novelty: A new item is more likely to be given attention.
Change: So too is some change in an item or set of items.
Expectation: The failure of items to conform to some established expectation can attract attention (e.g. a missed beat in a rhythm).
Magnitude: In a set of items, those whose features (size, volume etc.) possess greater magnitude are more likely to be attended. Those below a certain magnitude may be unlikely to be attended (p.21).
Difference: In a set of related items, an item which differs in some significant respect from the others is more likely to be attended.
Distraction: The absence of other items which compete for attention increases the chances of an item being attended (p.20).
Proximity: Items which are spatially close to an already attended item are more likely to be attended (p.21).

The suggestion is, then, that prompts can be used to increase the attentional value of the relevant features of the response. Both stimulus and response prompts can be used for this purpose. Some examples will serve to illustrate what is being suggested. Consider the operation of a push-button which requires and permits only a slight downward push for its operation. If a standard physical prompt or model were given in teaching this, it might be difficult for the learner to
discern the discriminating features of the action because it is so slight and comes in the midst of a range of other actions, and they might fail to discriminate it from, say, merely touching the button. The teacher could facilitate this discernment by increasing the magnitude and difference of the critical movement as it appears in the prompt. For example, in providing physical guidance or a model, the teacher could exaggerate the downward feature of the movement (a critical discriminating feature) by moving the whole arm and hand instead of just a finger. This idea relates to a suggestion made by Skinner (1968), and noted in Chapter 2 (p. 53), to the effect that non-verbal response prompts should be presented in an exaggerated form. The present discussion provides a rationale for the suggestion. The same example can serve to illustrate the use of stimulus prompts for this purpose. The task materials could be modified so that the movement required to operate the button was extended in length, thereby making it a clearer instance of the action of pushing down. This strategy was employed in the empirical investigations to be reported in Chapter 5.

Enabling an Approximate Response

In Chapter 2 (p. 64) we suggested another way in which stimulus prompts can be used to facilitate acquisition of the response component — namely, as a form of response shaping. It was suggested that they can be used to ensure that a less sophisticated approximation to the target response is effective in achieving the natural outcome of the response. Being less sophisticated, it may be more likely to occur in the learner's spontaneous attempts to complete the task, or in the learner's attempts to follow a response prompt. Once it occurs, it can be reinforced and its frequency thereby increased. The assumption of the behavioural account of the effectiveness of response shaping is that increasing the frequency of the approximate response can increase the probability of the next response in the series and eventually the criterion response relative to its probability under no-prompt training. However, we noted some gaps in this account. The justification for the above assumption is unclear. It was also left unclear about the precise ways in which stimulus prompts can make effective a less sophisticated response. The cognitive account can remedy these omissions. It also provides an additional reason why this form of stimulus prompt can be more effective.
In explaining how this type of stimulus prompt can be effective, the key insight brought by the cognitive approach is that behaviour in the learning situation can be systematically directed towards achieving the goal. Stimulus prompts of this type ensure that a less sophisticated approximation to the criterion response brings about the natural outcome, which is also the goal. Thus if the approximate response is made, the learner is presented with information about what the goal of the response is. Subsequently, when achievement of the goal is made dependant on the emission of a closer approximation or the criterion response itself, the learner may emit responses which are relatively systematic attempts to achieve the goal. A natural first step in such an attempt is to emit variants of the same general class of responses under which the learner encoded the original less sophisticated approximation. Provided that the stimulus prompts have not altered the essential nature of the response (i.e. that they are not spurious - p.68), then it is reasonably likely that one of these variants will be the closer approximation (or criterion response). This provides the basis for an explanation of why this type of stimulus prompt can be more effective than no-prompt training: Being less sophisticated, the approximate response is more likely to occur in the learner's spontaneous or response-prompted efforts to complete the task, than the criterion response is under no-prompt training. Once it has occurred, the learner is presented with information about what the goal of the response is and, provided that the prompts are not spurious, under what general response class the criterion response falls. When achievement of the goal is subsequently made dependant on emission of the criterion response, the learner, armed with this information, can systematically emit variants of the approximate response in an attempt to achieve the goal. The probability of these variants including the criterion response can presumably be greater that the probability of the learner discovering the criterion response under no-prompt training. In the latter case, the learner may have no information about the goal or the general nature of the required response, and hence may be confined to more random attempts to determine the criterion response.

This account permits us to justify the assumption of the behavioural account that increasing the frequency of an approximate response can
increase the probability of an even closer approximation and eventually
the criterion response relative to its probability under no-prompt
training. Increasing the frequency of an approximate response increases
the probability that the learner will encode and recall information about
the goal of the response and the general class to which the closer
approximation or the criterion response belong. This information gives
the learner an advantage in the search for the criterion response which
may not be present under no-prompt training.

The account also suggests an advantage that this type of stimulus
prompt may have over the more traditional form of response shaping in
addition to those discussed in Chapter 2 (p. 65). In the more traditional
form the approximate response does not bring about the natural outcome or
goal of the response. Accordingly, making the approximate response does
not, in itself, give the learner any information about what the goal of
the response is. If the learner has no knowledge of the goal, then, when
the reinforcement is made dependant on emission of a closer approximation
or the criterion response, though the learner may emit variants of the
initial approximation, the selection of these variants for emission will
not be guided by knowledge of the goal. Rather, they will presumably be
selected at random, or perhaps on the basis of an attempt to repeat the
initial approximation in a 'perfect' form. Such a strategy may often be
less likely to discover the closer approximation or criterion response
than a selection which is guided by knowledge of the goal of the
response, which may be the case when the stimulus prompt form of response
shaping is used.

The cognitive account also assists us in considering the specific
ways in which stimulus prompts can ensure that a less sophisticated
response is effective in achieving the natural outcome of the response.
In outlining this account in Chapter 3, we described three obstacles that
may prevent the successful execution of a response even when the learner
knows what to do - namely, a lack of power, a lack of precision, and an
excess of simultaneous attentional demands (p. 88). This, in turn,
suggests that by decreasing the degree of power, precision and/or
simultaneous attentional demands required for task completion, we can
increase the probability of an effective response being made. By the
same token, these measures should also enable an approximate response to
be effective. Moreover, even if the learner is capable of meeting the demands made on their power, precision and attention, a reduction in these demands may still increase the probability of an effective response being made. For learners may not always exercise their abilities to the full extent in making a response. For example, suppose a learner who is trying to determine the nature of a response which requires a high degree of accuracy, makes a response which is of the required class but which is not sufficiently accurate. Even though they are capable of making a more accurate response, the failure of the initial response may induce the learner to try out responses of alternative classes, rather than to persist with variants of the correct class.

The account, then, suggests that, in order to enable less sophisticated responses to be effective, stimulus prompts should be designed to reduce the degree of power, precision and/or simultaneous attentional demands required for task completion. Some examples will serve to illustrate what is proposed. To reduce the precision requirements in teaching a learner to thread cotton through a needle, we might initially use a needle with a large hole and cotton of a relatively large diameter. To reduce the power requirements in teaching a learner to turn a key in a lock, we might oil the lock in order to ensure that it operates more smoothly, or we might initially teach the learner on a lock which requires less force.

The reduction of simultaneous attentional demands merits more detailed discussion. Two types can be distinguished. First, they may be motor, in which case one motor response has to be performed simultaneously with another and the two may need to be co-ordinated. For example, in zipping up an item of clothing, one has to grip the zip and pull it at the same time, and these two actions may need to be co-ordinated (e.g. the power of the grip on the zip will typically need to be adjusted according to the degree of resistance to the pulling action).

1 For a small number of tasks, it may be necessary to use a slight degree of power in order to execute the response successfully - too much power will result in failure. In these cases, the task may be rendered easier by a prompt which increases the minimal degree of power consistent with successful execution.
Many visuo-motor tasks require the simultaneous execution and co­ordination of a gripping and a manipulative response. The probability of successfully pulling up the zip might be increased by a stimulus prompt which reduces the attentional demands made by the gripping action. In the case of simultaneous motor responses, the attentional demands they make can presumably be reduced by stimulus prompts which reduce the amount of power and precision required for their completion. For example, the size of the zip could be increased. Increasing the area of contact between the fingers and the zip would increase the friction between the two and thereby decrease the power required. A larger zip also requires a less precise grip. Simultaneous attentional demands may also be perceptual. In this case, the motor response has to be performed simultaneously with a perceptual response, and the two have to be co­ordinated. For example, in threading a needle, the learner, as well as making the required motor responses, also has to look at the needle and the end of the thread, and has to guide the motor response in accordance with the visual information received. Again, the probability of the motor response might be increased by reducing the attentional demands made by the visual response. One way of achieving this would be to increase the size of the hole and the thread, thereby decreasing the number of visual fixations required in completing the task.

We suggested in Chapter 3 that when the learner is not capable of meeting the demands on power, precision and attention made by the task, practice can assist by developing the required level of power or precision, and by making available more attentional resources (p.88). This suggests another advantage that this type of stimulus prompt (i.e. one which enables an approximate response) may have over no-prompt training. Provided that the prompted version is not completed in a spurious way, practice on it should improve the learner's power and/or precision in the ways required for completion of the criterion version; and reductions in the attentional requirements achieved by practice on the prompted version should transfer to the criterion version.

1 The reverse also applies. Reducing the attentional demands required by completion of the motor response will presumably increase the attention available for completion of the perceptual responses and may thereby facilitate their acquisition.
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We have discussed two accounts of how stimulus prompts may facilitate acquisition of the response component - one in terms of response shaping, and one in terms of increasing the attentional value of the relevant features. It should be noted that the two accounts differ in terms of the specific forms of prompt that they entail. Although a task modification may serve the purpose both of enhancing the discriminating features and decreasing the degree of power, precision and simultaneous attentional demands required for task completion, this is not necessarily so. For example, we may enhance the discriminating feature of a pushing action by increasing the length of the push required, but this modification may not reduce the degree of power, precision or simultaneous attentional demands required for execution.

Teaching about Goals

Another relatively novel implication of the cognitive account is that it may be advantageous to use prompts to provide or enhance information about the goals of the response. For example, with reference to the goals of pressing down the 'play' button on a cassette player (making the button click into place, making the tape play etc.), we might give the learner a prompt which contains information about the goal (e.g. "Listen for the click when you press it down.") or an attentional prompt which enhances the discriminating features of the outcome (e.g. a stimulus prompt which increases the volume of the click). It is rare to find examples of such prompts in the existing research. The importance of encoding information about the goals of a response in learning a skill was discussed in Chapter 3 (p.84). Encoding the goals is typically a far more effective method of acquiring a skill than simply forming stimulus-response associations, particularly when the skill requires non-identical movements on different occasions of its application (which is the case with the vast majority of practical skills) and when a relatively high degree of motor precision is required (relative to the individual's capabilities).

But will it be necessary to incorporate into a prompting strategy additional prompts specific to the goals? Or will a strategy which gives adequate information about (or adequately increases the attentional value of) the stimuli and the responses thereby also give adequate assistance
Types - Reconsideration

in respect of the goals? It seems likely that sometimes it will, but sometimes it will not. The outcome presumably depends on the nature of the prompt and the type of goal. Verbal prompts can serve to illustrate the significance of the type of goal. In Chapter 3, we drew a distinction between goals defined in terms of some alteration in the position of the body parts relative to the environment, and goals defined in terms of some event or change in the environment (p.81). Verbal prompts which provide the learner with adequate information about the stimuli and the responses will typically also provide adequate information about the first type of goal, but typically will contain no information about the second type of goal. Consider, for example, the task of turning on a rocker switch on a wall-mounted electrical socket. The initial goal is to bring a finger tip in contact with the bottom end of the switch. This is accordingly a goal of the first type. A verbal instruction which focussed only on the stimuli and the responses (e.g. "Put your finger on the bottom of the switch.") would nevertheless contain information about the goal. By contrast the subsequent goal is of the second type - the switch must be pressed down with sufficient force to ensure that the switch clicks into place and that the bottom end stays depressed and the top end raised. In this case, an instruction which contained reference only to the stimuli and the responses (e.g. "Push the switch.") would contain no information about the goal. In deciding whether the goals should be specifically prompted, the nature of the prompt also needs to be taken into consideration. For example, in the case of informational prompts, we must ask whether the prompt contains sufficient information about the goal, and whether that information has sufficient attentional value (see next section).

Promoting Generalization

The third relatively novel implication of the cognitive account concerns the use of prompts to facilitate generalization. Although the importance of taking direct steps to enhance generalization is widely recognised (p.91), it is rare to find any suggestion within the existing research to the effect that manipulations in the form of the prompt can achieve this. However, this notion is clearly implied by the cognitive account we have given. It has been argued that, for the purpose of generalizing an acquired skill, it is important that the learner should
classify the stimulus, response and goal at as general a level as possible consistent with the demand for discriminability (p.82), and that appropriate classification can be facilitated by a prompt which provides information about, or enhances, the relevant features of an item (p.96).

Taken together, these arguments suggest that prompts could be used to facilitate an appropriately general classification of the items, and thereby to facilitate the generalization of the skill. This could be achieved by ensuring that the prompts provide information about, or enhance the attentional value of, the relevant features which place the item in an appropriately general class, rather than those which are more particular to the specific circumstances of teaching. Again, the example of the cassette player may be used to provide a practical illustration. On any particular player, there will be several relevant features of the 'play' button which discriminate it from other aspects of the player - for example, its position, its relative size, its being marked with the word 'play' or with a single chevron. These features vary in their generality across different cassette players. Relatively few other players will have the button in the same position, but relatively many others will have the button marked with 'play' or a single chevron.

Application of the prompt to any of these discriminating features will promote acquisition of the ability to operate the particular player used in the training. Generalization of the ability to other players will be promoted by application of the prompt to those features (such as being marked with 'play' or a single chevron) which are shared by relatively more players.

Methods of Enhancing Attentional Value

Earlier (p.97), we listed some of the specific ways in which prompts might enhance the attentional value of a relevant feature. This list can be used to generate, and provide a rationale for, specific forms of prompt which are rarely applied in current practice. For example, it was suggested that the magnitude of the feature may determine its attentional value, and that items below a certain magnitude may be unlikely to be attended. This suggests the use of stimulus prompts to enlarge the relevant features. This may be particularly advantageous in the case that they are naturally small. For example, we suggested that it might facilitate acquisition if we were to increase the magnitude of the
relevant features of an otherwise slight movement (p.97). Magnifying the stimuli and goals may also serve to increase their attentional value. For example, one of the benefits of the application reported by Ager (1989) of larger buttons, stalks and holes in teaching buttoning skills, may have been to increase the attentional value of the goal (namely, that the button should pass through the hole and lie on the other side). Relevant features which are small are sometimes obscured by response prompts (p.53). Another potential benefit of magnification is to reduce this risk. (In addition to modifying the task equipment in order to increase the size of features, we might also consider using enlarged representations of the feature (drawings, photographs etc.), since they generally make fewer demands on teaching resources.)

Explicit Discrimination Training

Finally in this section, we consider an issue that is not directly related to prompting, but is nevertheless of considerable interest. The cognitive account stresses the importance of the learner classifying the stimuli, responses and goals at an appropriately discriminatory level - that is, at a level which discriminates the stimulus from other stimuli in the task situation, the goals from other potential outcomes, and the responses from other responses in the learner's repertoire (p.82). This suggests that it may be advantageous, in some circumstances, to teach these discriminations explicitly. Following this suggestion, discrimination training would not be confined to tasks in which the sole purpose is to select the correct stimulus (i.e. choice discrimination tasks), but would occur in the context of teaching more complex skills. For example, as part of teaching a complex perceptuo-motor skill, one might require the learner to select between a correct movement and a related, but incorrect, movement in order to enhance their ability to discriminate the correct movement. At least with respect to the stimulus component, the value of such an approach has also been noted in the behavioural literature (Skinner, 1953 and 1968; Holland, 1965). Examples of it being put into practice are, however, more difficult to find. Explicit teaching of discriminations appears to be largely confined to choice discrimination tasks, and rarely occurs in the context of teaching more complex tasks.
4.2: THE FORMAL DETERMINANTS OF VARIATION IN EFFECT

In summary, it will be suggested that formal variations can produce variation in effectiveness to the extent that they have an effect upon:

- the 'informational value' of the prompt
- the 'attentional value' conferred by the prompt
- the temporal properties of the prompt
- whether or not the relevant information is obscured by the prompt
- whether or not the prompt functions in a spurious manner

We shall consider each of these in turn.

The term 'informational value' is one that requires explanation. In order to do this, we require the distinction between informational and attentional prompts that was made earlier (p.97). In the case of an informational prompt, the term refers to the amount of relevant information about a task component that is contained in the prompt. For example, the instruction, "Push it down", contains more information about the response component than the instruction, "Push it". In the case of an attentional prompt, the term refers to the degree to which the prompt reduces uncertainty about the identity of the relevant features. For example, pointing precisely to the natural antecedent has a higher informational value than a vague pointing prompt which includes several stimuli in its scope.

The claim is, then, that the effectiveness of a prompt in ensuring that the relevant information is encoded is dependant on its informational value - prompts with higher informational value will, in some circumstances, be more effective than those with a lower informational value. These terms can be used to re-describe several of the claims made in the earlier discussions about the formal determinants. In discussing stimulus prompts, it was suggested that multi-dimensional prompts, or a sequence of several uni-dimensional prompts, can be more effective than a single uni-dimensional prompt in teaching multi-dimensional concepts (p.44). This claim can be re-described in terms of the single uni-dimensional prompt having a lower informational value in that it draws attention to only one of the several relevant dimensions. Also in connection with the use of stimulus prompts, it was suggested that non-specific prompts can be less effective than alternatives.
because, although they draw attention to the correct stimulus, they do not draw attention to the relevant feature within that stimulus (p.26).

We can re-describe this claim in terms of non-specific prompts having lower informational value - they fail to reduce uncertainty about the identity of the relevant feature to the same extent as the alternatives. Similar remarks apply to the claim that stimulus prompts which eliminate distractions in teaching discriminations can be more effective the more distractions they eliminate (p.25). The more distractions it eliminates, the greater is its reduction of uncertainty concerning the identity of the relevant feature.

Another of the earlier claims upon which the notion of informational value has some bearing is the one, made with reference to response prompts, that full prompts can be more effective than partial prompts (p.52). A full prompt of a specific type was defined, with reference to a particular task component, as one which provides the maximum assistance of that type in eliciting the overt response. We can readily translate this into cognitive terms: A full prompt of a particular type is one which provides (or enhances) the maximum amount of information that that type can provide (or enhance) concerning how to make the overt response. However, the cognitive approach also suggests an alternative definition of the full-partial distinction - namely, one which takes into account the fact that the learner needs to encode information about the relevant features, and not simply information about the overt response. In this case, a full prompt would be one which provides the maximum information about the relevant features. The advantage of this formulation is that the claim about full prompts being potentially more effective than coincides with the claim that prompts with higher informational value are potentially more effective. It would also serve to alert teachers to the need to ensure that the prompting strategy supplies (or enhances) all the required information about the relevant features, rather than that it elicits the overt response. However, the full-partial distinction appears to be defined in the existing research with reference to the overt response, and we shall retain this definition throughout the thesis.

The second factor to be considered is **attentional value**. We have already discussed this in the previous section. The attentional value of
an item refers to the probability of that item being attended, and specifically to that element of the probability which is determined by stimulus factors (as opposed to individual and situational factors) (p.96). We also listed some of the stimulus factors which determine attentional value (p.97). The notion of the attentional value conferred by a prompt requires some explanation. In general terms, it refers to the amount of attentional value conferred by the prompt on the relevant information (whether this information is contained within the prompt (for informational prompts) or the prompt draws attention to it (for attentional prompts)). In the case of informational prompts, this amount depends upon the attentional value of the prompt itself and, since such prompts may also contain irrelevant distracting information (p.97), the attentional value of the relevant information contained within that prompt. In the case of attentional prompts, the attentional value conferred depends simply on the extent to which the prompt increases the probability of attention being paid to the item to which the prompt is applied.

It is claimed, then, that the effectiveness of the prompt is dependant on the attentional value conferred to the relevant information by the prompt. Under this general claim we can include, with due re-description, various claims made in the earlier discussions of the formal determinants of effectiveness - for example, the claim that, in using stimulus prompts which exaggerate or introduce a difference between the stimuli in discrimination learning, larger differences are more likely to be effective (p.25), and the claim that, in using stimulus prompts to teach other skills, the prompt is more likely to be effective, the greater the extent to which the relevant feature is made to stand out (p.67). Various claims made about response prompts can also be included - such as the suggestion that irrelevant aspects (e.g. social stimulation) can interfere with the effectiveness of the prompt (p.53). The notion of attentional value can also be used to justify the need to eliminate extraneous distractions in the teaching situation and the use of secondary prompts (p.96).

A particular advantage of the current formulation is that it highlights the fact that the relevant information in an informational prompt may have a low attentional value, and it suggests a remedy for
this problem. Consider, for example, the use of full physical guidance to teach the learner to press down a button. Suppose that only a slight downward movement is required to operate the button. The prompt contains the information that a downward push is required. However, it also contains a great deal of other information, including much relating to movements. Against this background the information that a downward push is required may have very little attentional value. It may have no feature which makes it significantly different from the other movements and, being only a slight movement, its features may not possess sufficient magnitude to make it stand out. A remedy suggested by the current formulation is to use attentional prompts to draw the learner’s attention to the relevant parts of the informational prompt and/or to manipulate their attentional properties. The list of factors which determine attentional value (p.97) can be used to generate specific ideas. For example, we might attempt to reduce the amount of irrelevant information in the informational prompt and to reduce the attentional value of that which remains. This provides some justification for the frequent suggestion that, in using physical guidance, it is preferable for the teacher to stand behind the learner. In this way irrelevant social stimulation can be reduced. Another possibility would be to increase the difference between the critical features and the irrelevant features so that the former stand out (p.97). For example, stimulus prompts could be used to increase the magnitude of the critical features, and, when using response prompts, the teacher could exaggerate the critical parameters of the required movement (p.98).

The next factor on the list (p.107) concerns the temporal properties of the prompt. Obviously, the prompt will be ineffective if the learner is not given sufficient time to encode the relevant information from it. This is a straightforward re-description, in cognitive terms, of the need, identified in Chapter 2 (p.53), to ensure that the prompt is available for a sufficient length of time for the learner to follow it. As noted in Chapter 2, this implies that the effectiveness of a prompt may be increased, in some circumstances, by presenting them continuously until the response is performed, by delivering them slowly and/or by repeating them. Pictures and other forms of representation may have some value in this respect (cf. p.106).
In the same part of Chapter 2 (p.53), we also identified the need to ensure that response prompts do not obscure the relevant features. Translating this into the terms of the alternative approach, we need to ensure that response prompts do not obscure relevant information about the antecedents. So, for example, in using physical guidance, we need to ensure that the learner's view of what part of the task equipment is being manipulated, is not obscured. However, the alternative approach suggests an extension of the recommendation beyond response prompts and the antecedents, to stimulus prompts and to responses and goals. For example, we may need to exercise particular care to ensure that full physical guidance does not obscure visual information that may be important in classifying a particular response; and that stimulus prompts do not obscure relevant information about the antecedents, goals and responses.

In Chapter 2 (p.54), we defined a potentially spurious prompts as one which provides the learner with a basis for emitting the overt response which does not entail attending to the relevant features of the stimulus or the response (p.54). The reasons why such prompts may be less effective than non-spurious ones were also discussed in the earlier chapter (p.26). We can give an analogous definition in cognitive terms: A potentially spurious prompt is one which provides (or enhances the attentional value of) information which can be used to make the overt response without encoding the relevant information.
The discussions of prompt types in Chapters 2 and 4 gave rise to a wide range of hypotheses which stand in need of empirical support. The empirical investigations described in this chapter focus primarily on two general areas. Studies 1 and 2, described in Section 5.1, tested the effectiveness of stimulus prompts in teaching perceptuo-motor skills. Studies 3 and 4, described in Section 5.2, compared the effectiveness of full physical guidance with that of alternative prompt types. Although the studies were focussed on these two areas, their results do have implications for various other issues that were considered in the earlier chapters, and these implications will be discussed where appropriate.

5.1: THE USE OF STIMULUS PROMPTS IN TEACHING PERCEPTUO-MOTOR SKILLS

5.1.1: Introduction

In the earlier discussions of stimulus prompts, we discussed two ways in which they might facilitate the acquisition of perceptuo-motor skills - namely, by increasing the attentional value of an item (p.62, p.96) and by enabling an approximate response (p.64, p.98).

The use of stimulus prompts to increase the attentional value of a stimulus feature has been extensively investigated in the context of choice discrimination tasks (Section 2.1). Some researchers (e.g. Stoddard & Cerovac, 1981; Ager, 1989) have also suggested that they can effectively be used to increase the attentional value of the natural antecedents in tasks in which the antecedent is not readily confusable with other parts of the task equipment (i.e. there is not an explicit choice to be made between two or more similar stimuli) (p.62). We pointed out that the latter application, like the application to choice discrimination, may function in a spurious way if the prompt increases the attentional value of irrelevant features of the antecedent (p.63). Depending on the circumstances, prompts which have the potential to function spuriously may be less effective than non-spurious ones, and may...
even be countereffective (p.26). However, there are circumstances in which such prompts can be effective (p.27) and the probability of them being effective may be higher when the antecedent is not readily confusable (i.e. it is more discriminable) (p.60).

On the basis of the cognitive account, we suggested extending still further the application of this type of prompt. We argued that acquisition may be facilitated by using them to increase the attentional value of the relevant features of the responses and the goals, as well as the antecedents (p.96, p.103). The basic cognitive research also supplied us with a list of various specific ways in which attentional value might be increased (p.97), and this suggested some relatively novel forms that this type of prompt might take (p.105).

We also argued that stimulus prompts can facilitate acquisition of the response component by enabling a less sophisticated approximation to the target response to be effective in bringing about the required outcome of the response (p.64, p.98). In the context of the cognitive approach, we suggested that less sophisticated approximations can be enabled by prompts which reduce the degree of precision, power and simultaneous attentional demands required for successful execution of the response (p.100). It was suggested that such prompts can facilitate acquisition by means of eliciting the approximate response in the spontaneous response output of the learner (p.64) or by means of making functional an otherwise non-functional response prompt (p.66). The technological significance of the latter mechanism is that it may permit the teacher to avoid the use of functional but spurious response prompts, specifically full physical guidance (p.66). A functional but spurious response prompt may be less effective than a combination of a stimulus prompt and a less controlling but non-spurious response prompt.

With the exception of the application of the first type of prompt (increasing attentional value) in explicit stimulus discrimination tasks (p.17), experimentally controlled evidence for the effectiveness of these two types of stimulus prompt is scarce. A few studies have demonstrated the effectiveness of the first type when applied to the teaching of a choice discrimination component set within a more complex task (e.g. Mosk & Bucher, 1984). However, it is difficult to find any evidence for its
effectiveness when applied to an antecedent which is not readily confusable with other parts of the task equipment (p.67). Evidence is also lacking for the effectiveness of this type when applied to the response component or goal, and for the effectiveness of prompts which enable an approximate response (p.67).

Studies 1 and 2 were intended to fill some of these gaps in the evidence. The main hypothesis tested was that stimulus prompts of this nature can facilitate the acquisition of response components, and of distinct stimulus components (i.e. stimuli which are not readily confusable with other parts of the task equipment). In teaching the response component, both types of prompt (increasing the attentional value and enabling an approximate response) were applied, and care was taken to avoid the use of spurious prompts. In teaching the stimulus component, the attentional value of the natural antecedent was increased by both non-spurious (exaggerating the relevant feature) and spurious means (exaggerating or introducing an irrelevant feature). The small scale of the studies prevented the effects of these factors (enabling an approximate response vs increasing the attentional value of its relevant features; and spurious vs non-spurious increases in the attentional value of the stimulus) being individually tested in a systematic fashion.

Both studies were single-case multiple-baseline designs. In each, the learner was initially trained on several visuo-motor tasks using physical prompts. At staggered intervals, stimulus prompts were added to the prompting strategy (which otherwise remained the same) for those task components not acquired during the initial training. The effectiveness of the stimulus prompts was indicated by any relative improvement in performance after their introduction. The studies therefore provided a stringent test of the hypothesis in that it was confined to task components which the learners had failed to acquire during response prompt training, and which they therefore presumably found particularly difficult.
5.1.2: Method

Participants

The participant in Study 1 was a 39 year old woman resident in a hospital for people with learning disabilities. (All the participants in the empirical investigations were resident in the same hospital.) On the Merrill-Palmer Scale of Mental Tests (Stutsman, 1948), her score converted to a mental age of 22 months. On the Vineland Social Maturity Scale (Doll, 1965), her social age was assessed at 1.91 years. The participant in Study 2 was a 49 year old man. On the Merrill-Palmer Scale, his mental age was estimated at 21 months; and on the Vineland Scale, his social age was estimated at 1.97 years. Both participants were ambulant and had no major sensory deficits.

Tasks

Five different tasks were used in the two studies. Those used in Study 1 were unzipping a pencil case, operating the 'play' button of a cassette player, and unclipping a bundle of pictures. Study 2 involved turning on a water tap and unscrewing the lid of a jar, as well as two tasks from Study 1 (unzipping the pencil case and operating the 'play' button). For each participant, a preliminary assessment was conducted to determine which steps of the task the participant was unable to complete. On the basis of this assessment, a set of teaching targets and criteria for the successful completion of the response were established.

Stimulus prompts were devised for all the tasks with the exception of unclipping the bundle of pictures. They were not required for this task because the participant acquired it rapidly under the teaching strategy which used response prompts alone. As described in the Introduction, the prompts were intended:

- with respect to the stimulus component, to increase the attentional value of a relevant feature and/or an irrelevant feature
- with respect to the response component, to increase the attentional value of a relevant feature, and/or to ensure that an easier approximation to the criterion response would be effective in achieving the natural outcome of the response.
The methods of increasing attentional value were discussed in Chapter 4 (p.97). The prompts used here relied mainly on exaggerating magnitudes and differences. The methods of enabling approximate responses were also discussed in Chapter 4 (p.100). They involve the reduction of the degree of precision, power and simultaneous attentional demands required for response completion.

In what follows, we describe, for each task in turn, its basic nature; the teaching targets and the criteria for successful performance of the response; and the nature and purpose of the stimulus prompts that were applied:

1. Operating the Play Button

The play button was one of a panel of six buttons. For the criterion task a piece of white tape was placed on the top surface of the button to distinguish the play button from the others. The top surface measured 20 x 28 mm. To operate the button, it was necessary to press it down with a finger using sufficient force to ensure that it clicked into position. The button operated in a pivotal fashion such that, when it was clicked into position, the lower end was further down than the upper end. The teaching targets, and the criteria for successful performance of those targets, were set as follows for the participant in Study 1:
- to locate the play button - achieved if the participant touched the button in any way with her fingers
- to contact the button in the appropriate way - achieved if the learner placed the pad of the forefinger on the top surface of the button
- to operate the button effectively - achieved if the participant pressed the button down with sufficient force to ensure that the button clicked into place and the tape was played

During the preliminary assessment, the participant in Study 2 was successful in pushing down the buttons, but invariably selected the incorrect button or some other part of the equipment to press. The target for him was therefore set as the selection of the correct button, and the criterion for successful performance of this was that he should press the correct button.
In the modified version of the task (i.e., the version in which the stimulus prompts were applied), a thin piece of metal measuring 18 x 26 mm was attached to the top surface of the button, such that half of its length was in contact with the surface of the button and half protruded out from the panel of buttons. The metal was then covered in the same white tape that was used to cover the button in the criterion version of the task. Pressing down on the metal had the effect of pushing down the button. The button mechanism was also heavily oiled. These changes are illustrated in Figure 5.1.

These modifications were intended to facilitate the acquisition of each teaching target in the following ways:

(i) Locating the button: The modifications were designed to increase the attentional value of the button. This was achieved partly by means of enhancing the attentional value of its critical features (by providing a larger area of white to stand out against the other black buttons) and partly by spurious means (the fact that the metal protruded out from the panel provided a spurious basis for selecting the button).

(ii) Contacting the button: Since the buttons were reasonably large in their natural state, the modifications would presumably not have facilitated the performance of this step.

(iii) Operating the button: Oiling the button meant that less power was required to operate it effectively, so that an approximate response would be effective. The metal attachment was intended to increase the attentional value of the critical features of the required movement. For, since the button operated in a pivotal fashion and the attachment
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extended beyond the lower end of the button, the length of the downward movement required to click the button into place was increased when the lower end of the attachment was pressed (p.98). A related consequence was that the power required to operate the button effectively was reduced, since the leverage provided by the lower end of the attachment was greater.

2. Unzipping a Pencil Case:

The pencil case was oblong in shape (100 x 225 mm), mainly black in colour and the zip ran along its top. The zip-slide was a dark metallic colour and the tag by which it was gripped measured 13 x 5 mm. To unzip the case effectively, it was necessary to take the zip-slide in one hand and the short side of the case next to the zip-slide in the other (see Figure 5.2). The preliminary assessments indicated that neither participant knew where to get hold of the case in order to open it, but that, once they had been prompted about where to place their grip, both were able to grip the slide and the adjacent side in an appropriate way. The teaching targets, and the criteria for achievement of those targets, were accordingly set as follows:

- to locate the zip-slide - achieved if the participant gripped it in a pincer grip
- to locate the adjacent side - achieved if the participant gripped it in a pincer grip
- to operate the zip-slide - achieved if the participant moved it to at least half way down the zip

In the modified version of the task, white tape was attached to the side of the pencil case at the point at which it was most advantageous to grip it. The tape covered an area of 20 x 20 mm on each side of the case. A small piece of wood was attached to the tag of the zip-slide and held in place by white tape. This increased the size of the tag to 35 x 20 mm. The zip was also oiled heavily. These modifications are illustrated in Figure 5.2.

The prompts had the potential to facilitate the acquisition of each step in the following ways:

(i) Locating the zip-slide: Making the zip-slide white and bigger
presumably increased its attentional value—partly by spurious means (making it white introduced a spurious basis for its selection) and partly by means of its critical features (making it bigger made it more noticeable as the piece which protruded from the top of the case).

(ii) Locating the side: Placing a white square on the appropriate place presumably increased the attentional value of that place (by making it stand out against the black of the rest of the case), but did so in a wholly spurious way (i.e. it did not enhance the critical features of the side in any way).

(iii) Operating the slide: Oiling the mechanism would have reduced the power required for its effective operation. Operation of the slide was dependant upon a simultaneous gripping of the slide (i.e. a simultaneous attentional demand of a motor nature - p.101). The enlargement of the zip-slide permitted a less precise grip on the slide to be effective. The enabling of an approximate grip may have reduced the simultaneous attentional demands and thereby increased the attentional resources available for learning how to operate the slide (p.102).

3. Turning on a Water Tap:

The tap used in the criterion task was of the four-armed star variety. Its operation required rotation of the tap-head in a horizontal plane through approximately 40 degrees. The distance from the tip of one arm to the tip of the opposite arm was 55 mm. On the preliminary assessment, the participant, when asked to turn on the tap, was able to adopt a reasonable grip on the tap-head, but was unable to operate it.
Accordingly, only one teaching target was set - namely, the operation of the tap. This was considered to have been achieved if the participant rotated the tap-head sufficiently to ensure a steady flow of water (drips of water were not accepted).

The stimulus prompt for the task consisted of a device made from a rigid plastic pipe, two screws and some black tape. The two screws, wrapped in black tape, extended out from opposite sides of the pipe. The distance from the tip of one arm to the tip of the other was 120 mm. The pipe was 65 mm in length, and 40 mm in diameter. Holes and slots were cut into the pipe so that it fitted securely onto the arms of the tap. Rotating the arms of the pipe had the effect of rotating the arms of the tap and thereby operating the tap. These modifications are illustrated in Figure 5.3.

Figure 5.3: Modifications to the Tap

![Diagram of Modifications to the Tap]

The distance of the tips of the arms from the centre on the stimulus prompt was greater than it was on the criterion task (120 vs 55 mm). Consequently, less power was required to operate the tap, and thus the prompt enabled an approximation to effect the natural goal. The modification also increased the distance through which the arms had to be rotated in order to operate the tap. This exaggeration of this critical feature of the required response (i.e. rotation) may have increased its attentional value, both in visual and motor terms.
4. Unscrewing a Jar

A typical glass jam-jar was used, measuring 130 mm in height and 65 mm in diameter. The lid needed to be rotated through approximately 30 degrees in order to remove it completely from the jar. Again, during the preliminary assessment, the participant was able to adopt an effective grip on the lid with one hand, and on the body of the jar with the other. However, he simply tried to pull the lid away from jar, rather than rotating it. Accordingly, the only set teaching target was the effective operation of the equipment. This was judged to have been achieved if the participant rotated and pulled the lid sufficiently to ensure the complete separation of the lid from the body. The stimulus prompt consisted of attaching three bosses to the rim of the lid, each of which protruded 10 mm from the rim. These changes are depicted in Figure 5.4. The rationale for these changes was that the bosses would supplement the resistance to the fingers already supplied by the friction between lid and fingers, and that therefore it would take less power to rotate the lid. Moreover, when the lid was being rotated, the bosses would presumably have supplied a more obvious visual indication that rotation was occurring.

Figure 5.4: Modifications to the Jar

5. Unclipping a bundle of pictures

Twenty pictures cut from magazines and catalogues were held together by a bulldog clip. The teaching targets, and criteria of success, were
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set as follows:
- to locate the clip - achieved if the participant touched the clip with her fingers
- to grip the clip appropriately - achieved if the participant gripped the clip in a pincer grip, with the thumb and finger on the outer sides of the two levers of the clip
- to operate the clip effectively - achieved if the participant squeezed together the two levers with sufficient force to permit the complete separation of the clip from the pictures.

As already noted, no stimulus prompts were required for this task.

Procedure

In both studies, each session was composed of three teaching trials and two probe trials for each task. One probe trial was given before, and the other after, the three teaching trials (a 'pre-' and a 'post-teaching probe'). Within a particular session, all the trials for one task were administered before the pre-teaching probe trial for another task was administered - that is, the trials for the different tasks did not overlap. The order in which the different tasks were taught was varied at random across sessions. There was an interval of at least 60 seconds between each trial during a session. In both studies there were typically two sessions each week.

In the first two sessions of both studies, each task was taught using full physical prompts alone. In the third session, the strategy using partial and full physical prompts was introduced for every task. The strategy combining stimulus and response prompts was then introduced after varying intervals.

The first of these strategies consisted in giving the learner full physical guidance immediately upon presentation of the task materials. In the subsequent procedure using partial and full physical prompts, the task was presented, and a general instruction to complete the task was given (e.g. saying "Open this", and pointing to the task). The participant was then given 5 seconds in which to complete the first step of the task. If this was not successfully achieved (success being defined in terms of the criteria described earlier), then a partial
physical prompt was given. The participant was then given a further 5 seconds in which to complete the step. Failing this, full physical guidance was then given to ensure completion of the step. The same procedure was then applied to the next step in the task. The teaching trials involving the stimulus prompts made use of the same procedure, with the exception that the modified task equipment was used.

The probe trials were identical to the teaching trials using partial and full physical prompts. The criterion task was always used on these trials, even after the stimulus prompts had been introduced. The learner was adjudged to have completed a step successfully if they met the criterion for that step without assistance and within the 5 seconds allowed.

The partial prompts used were of the 'automodel' type (p.50). In respect of the response component, they involved the teacher moving the learner's hand (appropriately gripped about the equipment) in the required direction, but stopping short of achieving the teaching target. For example, in the case of turning on the tap, the teacher rotated the learner's hand in the required direction, but not to such an extent that water came from the tap. In respect of the stimulus component, the partial prompt for locating the button on the cassette consisted of the teacher moving the participant's hand to a point approximately 2 inches from the button; and the partial prompt for adopting the appropriate contact with the button consisted of the teacher touching the participant's forefinger and slightly bending the other fingers. The partial prompt for the steps of locating the zip-slide and the adjacent side of the pencil-case consisted of the teacher moulding the participant's fingers into the appropriate grip and moving them to a point approximately 2 inches from the appropriate part of the equipment.

Upon successfully completing each step, the learner was praised and given verbal feedback about the effectiveness of the response (e.g. "That's right. Well done."). Intrinsic reinforcement was provided by some natural consequences of task completion. Opening the jar, pencil case and clip gave access to items inside that the participants enjoyed using (e.g. pencils); operating the tap provided the opportunity to do some favoured activity with the water; and operating the cassette...
provided the opportunity to listen to music.

5.1.3: Results

The results provided evidence for the effectiveness of the stimulus prompts that were used. Figure 5.5 shows the results of the pre- and post-teaching probes for those six of the nine teaching targets in Study 1 to which stimulus prompts were applied (those relating to the removal of the clip are omitted because the task was acquired so rapidly). An effect for the stimulus prompts was predicted for five of these six. The prompts were not expected to have an effect on making the appropriate contact with the cassette button (p.117). In the case of two of these five targets (operating the zip, and operating the button), there was a clear association between the introduction of the stimulus prompt and the acquisition of the teaching target. In both cases, the participant had failed to perform the step independently on any probe trial during the response-prompt-only phase, but quickly and reliably began to do this after the introduction of the stimulus prompts.

Some other points of interest emerged from Study 1. In respect of the two targets whose acquisition was clearly facilitated by stimulus prompts, full physical prompts had been required on all the teaching trials under the response-prompt-only procedure. After the introduction of the stimulus prompts, full physical prompts were never required on the teaching trials for either target, and, in the case of operating the button, partial physical prompts were never required either. In respect of the three targets which the stimulus prompts clearly failed to facilitate, the learner continued to require full physical guidance on nearly all the teaching trials even after the introduction of the stimulus prompts. It was the case, then, that the stimulus prompts were not functional for these targets, rather than being functional but ineffective.

Figure 5.6 shows the results of the probes for the six teaching targets of Study 2. Stimulus prompts were introduced for all six targets. An effect was predicted for five of these. An effect was not predicted for the operation of the zip because the learner had already acquired the step before the stimulus prompts were introduced. For three
Types - Investigations

Figure 5.5: The Results of Study 1

**CASE**

<table>
<thead>
<tr>
<th>Locate side</th>
<th>RPO</th>
<th>S+R</th>
</tr>
</thead>
<tbody>
<tr>
<td>pr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CASSETTE**

<table>
<thead>
<tr>
<th>Locate</th>
<th>RPO</th>
<th>S+R</th>
</tr>
</thead>
<tbody>
<tr>
<td>pr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pr</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**KEY:**

- 0-0 Pre-teaching probe
- # # Post-teaching probe
- RPO Response prompts only
- S+R Stimulus and response prompts
Figure 5.6: The Results of Study 2

<table>
<thead>
<tr>
<th>CASSETTE</th>
<th>RPO</th>
<th>S-R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locate</td>
<td>npr</td>
<td>pr</td>
</tr>
<tr>
<td>Locate</td>
<td>pr</td>
<td></td>
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<tr>
<td>Locate</td>
<td>npr</td>
<td>pr</td>
</tr>
<tr>
<td>Locate</td>
<td>pr</td>
<td></td>
</tr>
<tr>
<td>Operate</td>
<td>npr</td>
<td>pr</td>
</tr>
<tr>
<td>Operate</td>
<td>pr</td>
<td></td>
</tr>
<tr>
<td>TAP</td>
<td>npr</td>
<td></td>
</tr>
<tr>
<td>Operate</td>
<td>pr</td>
<td></td>
</tr>
<tr>
<td>JAR</td>
<td>npr</td>
<td></td>
</tr>
<tr>
<td>Operate</td>
<td>pr</td>
<td></td>
</tr>
</tbody>
</table>

**KEY:**
- 0-0 Pre-teaching probe
- pr prompt required
- no prompt required
- RPO Response prompts only
- S-R Stimulus and response prompts
of these five targets (operating the tap, locating the zip-slide, and locating the button), the introduction of the stimulus prompts was clearly associated with the acquisition of the target.

Again, there are some other points of interest. In the case of the initial four teaching trials using the modified version of the tap, the participant required some physical guidance to ensure that he got hold of the device in an appropriate way, and that he operated it effectively. In the case of locating the zip-slide and the button, he did not require even partial physical prompts on the teaching trials after the introduction of the stimulus prompts. In the case of the two targets which the stimulus prompts failed to facilitate (operating the jar, and locating the adjacent side of the pencil-case), the stimulus prompts failed to elicit the required response on the teaching trials and the learner continued to require full physical guidance. As with Study 1, the prompts were not functional, rather than functional but ineffective.

5.1.4: Discussion

The main hypothesis tested in these two studies was that stimulus prompts which increase attentional value and/or which enable an approximate response can facilitate acquisition of the response component in visuo-motor tasks, and that, in the case of the first type of prompt, they can facilitate acquisition of a distinct stimulus component (i.e. a stimulus component which is not readily confusable with other parts of the task equipment). The results supported this hypothesis. Acquisition of the component was clearly associated with the introduction of the stimulus prompts for 2 of the 5 targets in Study 1 and for 3 of the 5 targets in Study 2 (see Table 5.1). The prompts facilitated the acquisition of both the response (3 out of 4) and the stimulus (3 out of 7) components. At least one of the stimulus components whose acquisition was facilitated by the use of the prompts was a distinct stimulus (i.e. the zip-slide - it is less clear that the cassette button can be considered as such). These rates of success should be considered in the context of the fact that the stimulus prompts were applied only to those components which the participants had failed to acquire under response prompt training, and therefore their effectiveness was subject to a stringent test (p.114). The results are of particular interest given the
lack of experimentally controlled investigations of the effectiveness of stimulus prompts to tasks other than choice discrimination (p.113).

In applying the prompts to teaching the response components, no systematic attempt was made to separate the effects of the two types of prompt mechanism (increasing attentional value and enabling an approximate response). Indeed, it will be apparent from Table 5.1 that most of the successful prompts might have had their effect by either mechanism or by both. However, the prompt applied to the operation of the zip was hypothesized to have its effect solely by means of enabling an approximate response (p.119). This prompt proved effective.

Table 5.1: Summary of Successes, Failures and Hypothesized Mechanisms of Effect

<table>
<thead>
<tr>
<th>Study 1</th>
<th>Study 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Successes</strong></td>
<td><strong>Successes</strong></td>
</tr>
<tr>
<td>Operating zip (E)</td>
<td>Operating tap (E,A)</td>
</tr>
<tr>
<td>Operating button (E,A)</td>
<td>Locating zip-slide (A,AS)</td>
</tr>
<tr>
<td>[Locating zip-slide (A,AS)]</td>
<td>Locating button (A,AS)</td>
</tr>
<tr>
<td><strong>Failures</strong></td>
<td><strong>Failures</strong></td>
</tr>
<tr>
<td>Locating case side (AS)</td>
<td>Locating case side (AS)</td>
</tr>
<tr>
<td>Locating button (A,AS)</td>
<td>Operating jar (E,A)</td>
</tr>
</tbody>
</table>

[The letters in brackets refer to the mechanisms by which the prompt was intended to facilitate acquisition of the target. A indicates increasing the attentional value of the critical features of the stimulus or the response; AS indicates increasing the attentional value of the stimulus by spurious means; and E indicates enabling an approximate response.]

Similarly, in devising prompts for the stimulus component, no systematic attempt was made to separate the effects of an increase in the attentional value of a relevant feature (the non-spurious mechanism) from the effects of an increase in the attentional value of an irrelevant feature (the spurious mechanism). Again, it will be apparent from Table 5.1 that most of the prompts confounded the effects of the two mechanisms. It is interesting to note, however, that the prompt for locating the side of the pencil-case provided only a spurious means of
classifying the stimulus component (p.119) and that this prompt was clearly ineffective in both studies. However, as noted in the Results section (p.124, p.127), the prompt was not functional in either study. This indicates that we must explain its lack of effectiveness in terms of a failure to control the overt response, rather than in terms of its provision of a spurious basis for selecting the stimulus.

A lack of functionality, rather than their spurious nature, also underlay the other two prompt failures (locating the cassette button in Study 1 and operating the jar in Study 2) (p.124, p.127). In both cases, the participant had established a strong but incorrect response prior to the introduction of the stimulus prompts. The incorrect response was 'strong' in the sense that it occurred on nearly all the teaching and probe trials. As we shall discuss in Chapter 6, the establishment of these errors may have interfered with the acquisition of the correct response.

The studies also have some bearing on other issues concerning prompt types that were discussed in Chapters 2 and 4. The first of these concerns the use of prompt combinations. In Chapter 2 (p.73) we argued in favour of prompt combinations. A combination may be more effective under some conditions than either prompt (or an alternative) used alone because the two prompts may control different components of the required behaviours, or their combined control of a particular component may be greater than that exercised by either prompt alone. Put in cognitive terms, a combination may possess greater informational value or confer greater attentional value (p.107). We suggested that combinations may be particularly useful when the only alternative is a functional but potentially spurious prompt (specifically, full physical guidance) (p.74). In Chapter 2 (p.74), we also considered the arguments against the use of prompt combinations. These are based on the claim that people with a learning disability will find it very difficult to attend to two or more prompts as well as to the natural antecedents. Our reply to this argument was that, although some combinations will indeed place impossible attentional demands on some learners, we can avoid such an outcome by careful attention to the formal and procedural properties of the combination (e.g. by presenting the prompts continuously until the response is made, or by presenting them sequentially rather than
The present studies lend support to these earlier arguments. The combination of stimulus and response prompts proved more effective than the response prompts alone. The same result was observed by Gold and Barclay (1973) and Mosk and Bucher (1984) (p.76). Further, although none of these studies tested whether the combination was more effective than the stimulus prompts alone, at least in the present studies this seems a likely outcome. It seems particularly likely in respect of the response components of the tasks, since the stimulus prompts would not have provided any assistance until the response had been performed (p.62).

Indeed, it could be argued that the combination was not only more effective than either prompt used alone, but also that it would have been more effective than any alternative prompting strategy. Both participants had a severe-to-profound learning disability and, given the failure of physical guidance, it is difficult to imagine what other prompting strategy would have been effective. If the combination was the only effective way in which the participants could have acquired the targets whose acquisition the stimulus prompts facilitated, then the stimulus prompts made an essential contribution to their acquisition — that is, the participants would not have learnt these steps without the use of stimulus prompts. If this is the case, then it indicates an urgent need for further research on the application of such prompts, and it provides useful ammunition in countering the arguments against the use of stimulus prompts because of their impracticality (p.77). Such arguments lose their force in situations in which the use of stimulus prompts is necessary if the skill is to be acquired. There are other ways, too, in which the present studies undermine these arguments against the use of stimulus prompts. They provide evidence to support the suggestion that the impracticality of stimulus prompts can be alleviated, without necessarily destroying their effectiveness, by using only one easy version of the task rather than a series (p.77). Indeed, the transfer of understanding from the easy version to the criterion version was very rapid in most of the effective applications of stimulus prompts. The participants were successful on several of the first post-teaching probes to be conducted after the introduction of the criterion version, and there was no need for a lengthy period of training on the easy version prior to the introduction of the criterion version. The charge
of impracticality was also to some extent undermined, in that the easy versions of the tasks were fairly rapidly produced using readily available and cheap household materials.

Finally, it is worth noting that the studies provided further examples of prompts (in this case full physical guidance) which were functional (i.e. they reliably elicited the correct response during teaching) but, despite very lengthy periods of training, were ineffective (i.e. the correct response failed to occur in the absence of the prompts). Other examples of this were provided in Chapter 2 (p.18, p.46). Together, they support the fundamental argument that, in devising a prompting strategy, it is not sufficient merely to elicit the overt response, one must also elicit the necessary precursory behaviours (p.18, p.46) or, in the terms of the cognitive approach, one must also ensure the encoding of the relevant information (p.95).

5.2: THE COMPARATIVE EFFECTIVENESS OF FULL PHYSICAL GUIDANCE AND ALTERNATIVE P롬PT TYPES

5.2.1: Introduction

It has been claimed, particularly in reference to people with a more severe learning disability, that full physical guidance (FPG) is the most effective form of prompt (Hayden et al., 1976; Walls et al., 1979; Hourcade, 1988 - p.55). The theoretical basis for the claim is the fact that FPG is the most functional form of prompt - that is, it is the most effective at eliciting the overt response (Walls et al., 1979). When combined with the traditional assumption that the elicitation and reinforcement of the overt response is necessary and sufficient to ensure acquisition (p.18, p.46), it follows that FPG must be the most effective form of prompt. Empirical support for the claim derives from a number of studies in which FPG proved more effective than alternatives (Nelson et al., 1975; Close et al., 1978 - p.57). However, there are also some studies in which the alternatives proved equally effective (Walls et al., 1979; Hourcade & Parette, 1985; Hourcade, 1988 - p.57). In the light of this, the claim must be restricted to the proposition that FPG is always more effective or at least as effective as the alternatives (i.e. is never less effective), rather than that it is always more effective (i.e.
that it has overall, rather than universal, superiority - p.13). The empirical evidence, such as it is, appears to be consistent with this proposition in that it is difficult to find any study in which alternatives have proved more effective than FPG.

However, the claim can be challenged on theoretical grounds (p.55). We provided theoretical and empirical grounds for rejecting the traditional assumption which underlies the claim (p.18, p.46). To be effective, it is not sufficient for the prompt to elicit the overt response. Rather, it must elicit the necessary precursory behaviours or, in cognitive terms, it must ensure that the relevant information is encoded. Although FPG may be the most effective way of eliciting the overt response, it is far from clear that it is the most effective way of eliciting the necessary precursory behaviours (of ensuring that the relevant information is encoded). The problems associated with FPG in this respect can be best appreciated by evaluating it in terms of the list of formal factors which we identified in Chapter 4 (p.107) as determinants of the probability that the prompt will ensure that the relevant information is encoded:

(i) The informational value of the prompt: FPG should, in principle, contain all the relevant information.
(ii) The attentional value conferred by the prompt: In respect of informational prompts such as FPG, this criterion refers to the attentional value of the relevant information contained in the prompt, and to the attentional value of any irrelevant information (p.109). Some of the formal factors which determine attentional value were listed in Chapter 4 (p.97). Consideration of FPG in relation to these factors indicates that the relevant information contained within FPG may often have a relatively low attentional value. For example, in fine motor tasks the critical manipulatory movement may have low attentional value because it does not stand out against the other irrelevant movements contained in the prompt and is of low magnitude (p.110). Moreover, FPG contains a great deal of irrelevant tactile and social stimulation of high attentional value which may distract from the relevant information (p.53, p.110).
(iii) The temporal properties of the prompt: FPG may not always present the relevant information for a long enough period of time to give the learner sufficient opportunity to encode it.
(iv) Whether or not the relevant information is obscured: In using FPG, there is often a considerable risk, particularly in the context of fine motor tasks, that the hands of the learner and/or teacher will obscure the learner's view of the stimuli, responses and goals, and thereby prevent the learner's determination of the relevant information (p.111). We have previously emphasized that visual information is often useful, and may even be necessary, if the learner is to classify the response component appropriately (p.111).

(v) Whether or not the prompt provides a spurious basis for making the overt response: As we noted in Chapter 2 (p.54), FPG always provides a spurious basis for task performance, in respect of both the stimulus and the response component. Indeed, it is always possible for the learner receiving FPG to 'make' the overt response without paying any attention whatsoever to the prompt or to the task equipment.

To this list we may add two motivational sources of potential difficulty for FPG. It has been observed in existing research that some individuals find physical guidance aversive and consequently resist it (p.60). We also discussed the suggestion that FPG may reduce the initiation of independent responses (p.78). Both of these consequences may interfere with the encoding of the relevant information.

In the light of these difficulties, the claim that FPG has overall superiority over alternative forms begins to look distinctly untenable. It is most plausible to suppose that there are circumstances in which FPG is affected by one or more of these difficulties, but alternatives can be devised which confer a higher attentional value, which provide adequate time for the decoding of the prompt, which are not spurious and/or which do not obscure the relevant information. If the learner is able to follow (decode) these alternatives, then we might expect that, in some circumstances at least, they will be more effective than FPG.

Studies 3 and 4 provided a test of this supposition that FPG may, in some circumstances, be less effective than alternative forms of prompt. The experimental design of the two studies, like that of Studies 1 and 2, involved a multiple-baseline across tasks in the context of a single-case study. In the initial phase, the participant was taught several visuo-motor tasks using FPG in a prompt-delay procedure. At staggered intervals, alternative forms of prompt were introduced, within the same
procedure, to replace the FPG. An association between the introduction of the alternatives and an improvement in unassisted performance would support the hypothesis that the alternatives were more effective. In Study 3, the alternatives consisted of a combination of verbal instructions and modelling or gestural prompts, with partial physical prompts being used as a back-up. In Study 4, the alternatives consisted of a combination of stimulus prompts and partial physical prompts. The alternatives for each component were designed with a view to avoiding one or more difficulties associated with the use of FPG for that component.

5.2.2: Method

Participants

The participant in Study 3 was a 44 year old woman. On the Merrill-Palmer Scale of Mental Tests (Stutsman, 1948), her score converted to a mental age of 26 months. On the Vineland Social Maturity Scale (Doll, 1965), her social age was assessed at 2.2 years. She was ambulant and had no major sensory deficits. The participant in Study 4 was the same person who had participated in Study 1.

Tasks

Four tasks were taught in Study 3: Operating a rocker switch on the base of a table lamp; turning on a water tap (the same task was used in Study 2 - p.119); unscrewing the lid of a glass jar (the same task was also used in Study 2 - see p.121); and using a pair of scissors. The scissors had large handles such that all four fingers could be placed through the hole for gripping. The task required the participant to pick up the scissors (whose blades were closed) from the table and to use them to cut through a two-inch strip of paper held taut by the teacher. On the basis of a preliminary assessment, the following teaching targets, and the criteria for successful performance of those targets, were set as follows:

Table lamp:
- to locate the button - achieved if the participant touched the button in any way with her fingers
- to contact the button in the appropriate way with her finger -
Types - Investigations

- to operate the button - achieved if the lamp was illuminated

Tap:
- to grip the tap appropriately - achieved if she closed her thumb and fingers about the tap-head
- to operate the tap - achieved if she rotated it sufficiently to obtain a steady flow of water (drips were not accepted)

Jar:
- to unscrew the lid - achieved if she rotated it sufficiently to separate the lid completely from the body of the jar

Scissors:
- to grip with her thumb - achieved if she placed her thumb in one of the holes and closed it about the handle
- to grip with her fingers - achieved if she placed her fingers in the other hole and closed them about the handle
- to open the blades - achieved if she pulled the blades wide enough apart to receive the whole width of the paper
- to position the blades - achieved if she placed them either side of the paper strip
- to operate the blades - achieved if she cut right through the strip

Two tasks were taught in Study 4. One was to turn on a water tap. The targets and criteria for success were the same as those used in Study 3. The second task was to remove the lid of a plastic container of the kind in which margarine is usually sold. Its maximum dimensions were 130 mm (length) x 85 mm (width) x 45 mm (height). To remove the lid, it was necessary to pull the tab placed at one corner of the lid. The teaching targets and criteria of success were as follows:
- to locate and grip the corner tab - achieved if she got hold of the corner tab in a pincer grip between thumb and finger
- to remove the lid - achieved if the lid was separated completely from the body of the container

Study 4 involved stimulus prompts. The stimulus prompts for the tap were the same as those used in Study 2 (p.120). The modification for the container consisted of increasing the size of the corner tab by which the lid was to be removed. The unmodified tab extended 10 mm from the rim of
the lid and had an area of approximately 60 mm². The modified tab extended 30 mm from the rim and had an area of approximately 750 mm². The rationale for this modification was that it would help the participant to locate the tab by increasing its attentional value, and that it would help her to remove the lid by reducing the simultaneous attentional demands demanded by the grip on the tab (since a less precise and less powerful grip was required on the tab when pulling it (p.102)).

Procedure

In Study 3 each session was composed of three trials for each task. Within each session all the trials for one task were given before the first trial for the next task. The order in which the tasks were taught was varied at random across sessions. There was an interval of at least 60 seconds between each trial. Two sessions usually took place each week. With the exception of those which took place during the first session, the trials were such that they served as both teaching and probe trials.

Each task was taught using FPG in the initial phase of the study. At staggered intervals, a combination of verbal instructions and modelling or gestural prompts (with a back-up of partial physical prompts) was introduced for those teaching targets which the participant had failed to acquire during the FPG phase. In the event, four targets were taught using this combination. The alternative prompts for these targets were as follows:

(i) Gripping the scissors with her thumb: 1. "Put your thumb.." (Verbal Instruction (VI)) + Teacher holds his outstretched thumb in front of participant (Gesture (G)). 2. "..into the hole" (VI) + Teacher places his thumb in the hole (Model (M)) [Back-up partial physical prompt (BUP) - teacher places participant's thumb at a point approximately two inches above the hole]

(ii) Gripping the scissors with her fingers: 1. "Put your fingers.." (VI) + Teacher holds his fingers up in front of participant (G) 2. "..into this hole" (VI) + Teacher points to hole (G) [BUP - teacher places participant's fingers approximately two inches above the hole]

(iii) Unscrewing the jar: "Turn it" (VI) + Teacher performs an exaggerated mime of turning the lid of the jar (G) [BUP - teacher turns
participant's hand some way in the required direction, but not sufficiently to remove the lid.

(iv) Operating the tap: As for (iii)

The FPG was delivered in the context of a prompt delay procedure. In the first session, the participant was given FPG immediately on task presentation. In subsequent sessions, she was permitted 5 seconds in which to complete the step independently before FPG was given.

When the alternative prompts were introduced, the participant was again given 5 seconds in which to complete the step independently. The combination of verbal instructions and modelling or gestures was then given. If necessary, the combination was repeated. If the participant failed to complete the step after this repetition, the back-up partial physical prompt was given. It was intended that if this also failed to elicit the required response, then a full physical prompt would be given. It was necessary to include this in the procedure because, if the step was not completed, then earlier successfully completed steps would not receive the intrinsic reinforcement of task completion, and, since they could not be performed without the completion of earlier steps, later steps could not be assessed. However, if FPG had been used to ensure completion of a step, then the results concerning that step could not have been used to support the hypothesis under test. For in that case, the experimental comparison would have been between FPG and a combination of FPG and the alternatives, rather than between FPG and the alternatives. In the event, FPG was not required to supplement the alternatives in Study 3. They were in Study 4, but only on steps which the participant did not, in any case, acquire. Accordingly, their use did not contaminate the evidence provided by that study for the greater effectiveness of the alternatives.

As in Studies 1 and 2 (p.123), the participant was praised and given verbal feedback about the effectiveness of her action whenever a response was completed. The natural consequences of task completion were also assumed to be reinforcing for the individual concerned.

The procedure in Study 4 was the same as that in Study 3 with the following exceptions: Each session involved, for each task, a pre-
teaching probe trial, five teaching trials, and then a post-teaching probe trial. The alternative prompts consisted of a combination of stimulus prompts and partial physical prompts. The partial physical prompt for the steps of locating and gripping the tab on the container, and for gripping the tap-head, involved moulding the participant's hand into the appropriate grip and moving it to a point approximately two inches above the relevant part of the equipment. The partial physical prompt for removing the container lid, and for operating the tap, involved moving the participant's hand in the required direction, but not sufficiently to achieve the desired outcome. Finally, in the FPG phase, the delay before use of the prompt was not introduced until the third session.

Reliability and Procedural Accuracy

For Study 3 measures were taken to assess the reliability of the teacher's ratings of whether or not the participant achieved the criterion of success, and to assess the accuracy with which the teacher implemented the procedure with respect to the form of the prompt and the time at which it was given. These assessments were completed with the aid of videotape recordings of four randomly-selected sessions. An interrater reliability index was obtained for the success ratings by comparing the ratings given by the teacher during the actual sessions with ratings made from the videotape by a person unaware of the hypothesis being tested. An assessment of the accuracy of procedural implementation was also provided by the independent assessor who judged whether the teacher's actual behaviour during the sessions matched the procedural requirements. The timing of the prompt was adjudged to be correct if it fell within 1 second of the specified time. A check on the reliability of these judgements was also obtained by comparing them with judgements made from the same tapes by the experimenter. On some occasions, the behaviour of the participant or the teacher could not be seen on the videotape. These instances were not included in the analysis.

The formula used for determining the indices was the number of agreements divided by the sum of the agreements and disagreements. The interrater reliability for the ratings of the participant's performance
was 98%. The interrater reliability for the ratings of the teacher's implementation of the procedure was 96%. The accuracy index with respect to the form of the prompt was also 96%, and the accuracy index with respect to the timing of the prompts was 90%. The timing errors, with one exception, never exceeded 2 seconds.

5.2.3 Results

The results of both studies were in the predicted direction. Figure 5.7 shows the results obtained in Study 3. The graph depicts the number of trials on which the participant correctly performed the step without a prompt. The results concerning the steps of switching on the table lamp, and opening and positioning the scissors, are not included because the participant acquired them so rapidly. There were four targets on which the participant failed to show much progress during the FPG phase - gripping the scissors with the thumb and with the fingers, unscrewing the lid of the jar, and operating the tap. On all four targets, she showed a rapid and sustained improvement following the introduction of the alternative prompts.

The participant's response to the alternative prompts is also of some interest. Typically, she repeated the verbal instructions aloud. After a few trials she then began to say the instructions prior to completing the task without assistance. The back-up of a partial physical prompt was required only for the step of gripping the scissors with her fingers. Full physical prompts were never required once the alternatives had been introduced.

The results of Study 4 were also in the expected direction. Figure 5.8 shows the results of the pre- and post-teaching probes for the four teaching targets. The learner showed no progress on any of these targets during the FPG phase, but showed rapid and sustained improvement on three of them after the introduction of the alternative prompts. Full physical guidance was not required for any of these three after the alternative prompts had been introduced. Indeed, partial physical prompts were rarely required either after the initial session in which the alternatives were introduced. However, she continued to need FPG for
Figure 5.7: The Results of Study 3

<table>
<thead>
<tr>
<th>Types</th>
<th>Sessions</th>
<th>FPG</th>
<th>ALT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCISSORS</td>
<td>Thumb grip</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fingers grip</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operate</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>JAR</td>
<td>Operate</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>TAP</td>
<td>Grip</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operate</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Graph shows the number of trials on which no prompt was required.

**FPG** Full physical guidance

**ALT** Alternative prompt types
Figure 5.8: The Results of Study 4

**KEY:**
- 0-0 Pre-teaching probe
- pr Prompt required
- ★-★ Post-teaching probe
- npr No prompt required

**Legend:**
- FPG Full physical guidance
- ALT Alternative prompt types
the step of adopting an appropriate grip on the tap-head. A well-learned error (placing her hand flat on the top of the tap-head) appeared to interfere with her acquisition of this step (cf. p.129).

5.2.4: Discussion

The hypothesis under test was that alternative prompts can be more effective than full physical guidance. This contradicts the claim that has been made that FPG has overall superiority over the alternatives (p.131). The results of Studies 3 and 4 were in the predicted direction. The introduction of alternative prompts produced a significant improvement in performance on task components which the participants had failed to acquire under training with FPG.

However, before the results can be accepted as confirmation of the hypothesis, an alternative interpretation of the results needs to be considered. The experimental comparison was, in fact, made between FPG, on the one hand, and, on the other, a two-phase strategy consisting first of FPG and then the alternatives - rather than a straight comparison between FPG and the alternatives. Consequently, we can conclude that the alternatives were more effective only if we have grounds for supposing that they would have been as effective even without the prior phase of FPG. The results of the studies do not in themselves offer any proof of this. Although the FPG failed to ensure that sufficient relevant information was encoded for the targets not acquired during the initial phase (sufficient to enable independent performance), nevertheless it may have ensured encoding of some part of that information, and it may have been the case that that part would not have been encoded had the alternatives alone been used. In this case, the prior phase of FPG would have been necessary to the effectiveness of the alternatives. One might wish to argue on intuitive grounds that the alternatives would have been as effective without the prior FPG phase. However, this would not have the status of an experimental confirmation, and we must conclude that the experimental design of the studies was not appropriate for testing the hypothesis.

Nevertheless, the results are not without interest. They show, like the results of Studies 1 and 2 (p.131), that the use of FPG alone may not
always be a very effective strategy for teaching people with more severe learning disabilities. Moreover, even if the alternative interpretation is correct, the results still provide evidence that the two-phase strategy (FPG followed by alternative prompts) was more effective than the strategy which used FPG alone. This suggests that, if FPG is used, the teaching strategy may sometimes be rendered more effective by supplementing its use with alternative prompts designed to reduce the risks associated with the use of FPG (p.132). The alternatives could be introduced in the manner used in Studies 3 and 4 - that is, after a series of trials which used FPG alone. Another option would be to use them in conjunction with the FPG on the same teaching trials from the beginning of training. For example, to counter the possibility that the relevant information in FPG may have a low attentional value (p.132), supplementary prompts, such as stimulus (p.98) or verbal (p.74) prompts, could be used to increase this value. Such prompts might also help reduce the problems associated with the spurious nature of FPG, since these may be less likely to occur if the relevant features have a high attentional value (p.28, p.55). In respect of the potential of FPG for obscuring the relevant information (p.132), we could reduce the risk by using stimulus prompts to enlarge the task materials or by using enlarged representations (p.106).

The form of the FPG itself can also be manipulated in order to reduce the associated risks. For example, the attentional value of the relevant information contained within FPG might be increased by exaggerating the discriminating features of the response as it is performed (p.98) and by measures to reduce the attentional value of the irrelevant information, such as standing behind the learner (p.110). Further, the temporal properties of FPG might be improved by repeating them or delivering them slowly (p.110), and care should be taken to ensure that relevant information is not obscured.

In the case of people with more severe learning disabilities, there is need for further research into novel alternatives to use in conjunction with FPG. For the more traditional alternatives (gestural and verbal prompts) may often be ineffective for this group of learners (p.59). Studies 1, 2 and 4 suggest that stimulus prompts merit investigation in this respect.
It is not our intention to suggest that the use of FPG should be abandoned. Undoubtedly, there are circumstances in which it can be effective (p. 50). As we shall see in Chapter 6, it also has a role in partial task training. Rather, the purpose is to draw attention to the need for it to be applied in a more cautious and sophisticated way than is often the case.

1 In partial task training, it is not necessary that the FPG should be effective in teaching the steps to which it is applied. Rather, the intention is that guiding the learner through these steps should facilitate acquisition of those remaining steps to which the FPG is not applied. Accordingly, the doubts we have raised about the effectiveness of FPG in teaching steps do not apply to its use in this context. See Section 6.6.
CHAPTER 6: REVIEW OF EXISTING RESEARCH - PROCEDURES

This chapter reviews the content of existing research as it relates to the procedural aspects of prompting. The sections consider fading (6.1); prompt delay (6.2); the relative merits of fading and delay (6.3); the avoidance of errors (6.4); pre- vs post-response prompting (6.5); and partial task training (6.6). For each of these general procedural variables, we discuss the evidence that it can have a facilitatory effect on acquisition; the mechanisms whereby it might have an effect; what variations in the form of the procedure can influence the effect; and what circumstantial factors can influence the effect. Other effects (on generalization and maintenance, on other aspects of the learner's and on teaching resources - p.3) are discussed where appropriate.

6.1: FADING

In general terms, fading can be defined as the procedure in which, after the response has been reliably elicited with one form of prompt, this prompt is replaced by another form with the intention of facilitating independent performance. In the case of stimulus prompts (i.e. those which alter the task materials in some way - p.1), it typically involves replacement of the original prompted version with one which more closely resembles the target version. In the case of response prompts (i.e. those which are constituted by some behaviour on the part of the teacher), it typically involves replacement with a prompt which is thought to exercise less control over the response. In discussing the issues, we need to give separate consideration to the fading of stimulus prompts, response prompts, and prompts (either stimulus or response) which function spuriously.

6.1.1: The Mechanisms of Effect

Stimulus Prompts

An account of why the fading of stimulus prompts can be more
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effective than persisting with the original prompt is possible in terms of stimulus generalization (Dorry & Zeaman, 1975). Basic behavioural research indicates that when training has established control over a response by a particular value of a stimulus variable, other values of that variable may also elicit the response (Davey, 1981). Moreover, the closer these other values are to the originally-trained value, the more likely they are to do this. If the probability of the response is plotted against the values of the variable ordered in terms of similarity, then the peak of the curve will occur at the originally-trained value and then will fall away. The curve will fall away sharply (i.e. the probability of the response will decline rapidly) if the learner has been taught to discriminate between two values of the variable (Jenkins, 1965), but this may also sometimes occur in the absence of any explicit discrimination training (Gutman & Kalish, 1956). In some applications of stimulus prompts, the stimuli are modified to such an extent that the initial training form of the relevant feature and its criterion form are so dissimilar that, at least with some learners, stimulus generalization is unlikely to occur. Accordingly, if the criterion form were introduced abruptly after a period of training with the initial training form, it would be unlikely to exercise any reliable control over the response. If, however, we use a fading series of forms which gradually approximate the criterion form and in which the similarity of each form to the next in the series ensures a high probability of stimulus generalization from one step to the next, then the probability of the criterion form gaining reliable control may be significantly increased.

There is an implied limitation in this rationale which needs to be made explicit. Fading will only be more effective than an abrupt withdrawal of the prompt when the initial training form and the criterion form are sufficiently dissimilar that stimulus generalization is unlikely to occur - or, more precisely, is less likely to occur than a successful progression through the fading series. In the case that they are sufficiently similar, then the account does not predict any advantage for fading. In this context, it is worth recalling that several studies have reported the successful application of stimulus prompts without fading (p.78), as did Studies 1, 2 and 4 which were described in Chapter 5.
A similar account might be contemplated in terms of the concept of 'stimulus classes' (p.91). According to Skinner (1935, 1938), stimuli belong to the same class if they can be substituted for each other in a contingency without significantly affecting the probability of the response (though Skinner was not always consistent on this point (Hinson, 1987; Malone, 1987)). Such a definition of stimulus classes prevents us from using the concept in offering a theoretical account of fading - for it has no meaning independent of what is observed (Hyland, 1981). Others, however, have offered an independent definition. For example, Hooper et al. (1982) suggest a definition in terms of relevant stimulus characteristics: All, and only, those stimuli possessing all the relevant characteristics are members of the class. However, this definition does not allow us to offer a rationale for fading in terms of stimulus classes. The form of the rationale would presumably need to be similar to that offered in terms of stimulus generalization: A response that has been established in reaction to a particular stimulus is more likely to be elicited by other members of the stimulus class to which that particular stimulus belongs, than by members of other stimulus classes. In many applications of stimulus prompts, the initial training form of the relevant feature and its criterion form do not belong to the same stimulus class (and so are unlikely to control the same response), but each sequential pair in the fading series do (and so are likely to control the same response). However, this account cannot be maintained given the above definition of stimulus classes. For if the initial and the criterion form of the feature do not belong to the same class, then, by the above definition, at some point in the series the forms must switch from belonging to the same class as the initial form to belonging to the same class as the criterion form. At the point of this switch, the response will therefore have to be transferred from one class to another, and the account fails to explain why that transfer is more probable than a transfer directly from the initial to the criterion form.

So far the rationale has been considered as it applies to prompts which facilitate learning about the stimulus component. By extension, we can also readily apply it to prompts which teach about the goals. What, though, of those which teach the response component? Again, the concept of 'response classes', at least as typically defined, does not offer a very promising basis for a rationale. Skinner's functional definition
(those responses which would have the same consequences in a given contingency belong to the same response class (Skinner, 1938)) does not permit a theoretical account. Horner et al. (1982) add to Skinner's definition the requirement that all the members of a response class must possess all the topographical features which define that class. An attempt to provide a rationale on this basis runs into the same difficulties as we encountered when using their definition of stimulus classes.

In any case, the issue may be too complex to be accommodated by a single rationale. For it will be recalled that we suggested two ways in which stimulus prompts might facilitate acquisition of the response component - by enabling an approximate response (p.64, p.98), and by increasing the attentional value of its discriminating features (p.96). We also suggested two ways in which the former type might have an effect - by ensuring that the learner encodes the required information (p.89), and by providing the learner with the practice necessary to enable successful execution of a task, the requirements of which are already understood (p.102). A rationale for fading can be offered in the latter case (i.e. when it permits necessary practice). For practice on the easiest version is presumably less beneficial than practice on more sophisticated versions. For example, the probability of being able regularly to hit the treble-20-section with a dart is presumably increased more by practice at hitting the 20-section than practice at just hitting the board, and the probability of being able to juggle with three balls is presumably increased more by practice with two balls than practice with one ball. If this is so, then fading prompts of the enabling type may sometimes be more effective than their abrupt withdrawal because the fading procedure permits practice at a more sophisticated level.

With reference to enabling prompts which function by ensuring that the relevant information is encoded and to prompts which increase the attentional value of the discriminating features of the response, it is difficult to suggest any major theoretical reason why fading might be effective. If the learner accurately encodes the discriminating features of the response on the initial prompted version, then presumably, provided that the prompt has not altered the essential nature of the
response (i.e. it is not spurious) (p.67), this knowledge will typically transfer readily to the criterion version. The only exception to this appears to be if the initial task modification has altered the appearance of the relevant stimulus component to such an extent that the acquired response does not generalize to the criterion stimulus. In this case, a gradual withdrawal of the modifications may prove more effective than an abrupt withdrawal for the reasons given in the rationale for fading the prompts applied in teaching about the stimulus component (p.145). It should be noted that this gradual withdrawal needs to focus on the stimulus aspects of the prompt, rather than on making gradual changes in the topography of the required response.

Response Prompts

One of the few explicit discussions of the reasons for fading response prompts is to be found in Skinner's book, 'The Technology of Teaching' (1968). His argument is couched in terms of stimulus control, and appears to be as follows: If the control exercised by a prompt is decreased, then the control exercised by the natural discriminative stimuli (the natural antecedents) will increase. If the control of the prompt is not decreased, then control by the natural antecedents will not increase. Increase in the control exercised by the natural antecedents is obviously necessary if the skill is to be acquired. Fading the prompt is a way in which the control of the prompt can be decreased. Therefore fading is more effective than continuing to present the prompt in its original form.

But what are Skinner's grounds for claiming that the control exercised by the natural antecedents will increase to a greater extent if the control exercised by the prompts is decreased, than if that control remains the same? His answer is unsatisfactory. After suggesting that some people may be puzzled by the fading of prompts in programmed

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1 This claim is almost certainly false, as we shall see later. However, it is not necessary for the purposes of the argument to make such a strong claim. His argument can be maintained by the weaker, but more defensible, claim that the control of the natural antecedents will not increase as much if the control of the prompt is not reduced.
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"If the student cannot respond, why should he not be given maximal help? As he works through the programmed text, for example, why should he not be permitted to look at all the correct responses? A distinction must be made between two kinds of help. The teacher helps the student respond on a given occasion, and he helps him so that he will respond on similar occasions in the future. He must often give him the first kind of help, but he is teaching only when he gives him the second. Unfortunately, the two are incompatible. To help a student learn, the teacher must so far as possible refrain from helping him respond."

This word play can only serve to compound one's sense of puzzlement. It certainly fails to provide a satisfactory answer to the question. In basing his answer on the unsupported claim that there is a distinction between two kinds of help, only one of which results in learning, Skinner simply begs the question - that is, his account assumes that which he is purporting to prove (namely, that faded help is better than maximum help). We may also note a lack of precision and an incompleteness in Skinner's account. Does the reduction in the prompt's control refer to its control over the overt response, the necessary precursory behaviour, or both? In providing a less controlling prompt, should the aim be to provide one which is less likely to elicit the response in the actual circumstances of application, or one which is less likely to elicit it in the hypothetical circumstances in which the learner has received no prior training on the response? Most importantly, the account tells us nothing about those features of a prompt which determine the degree of control it exercises. Consequently it does not provide clear general guidelines about how we should alter or replace a prompt in order to reduce the control that it exercises. As we shall see, this omission has led to considerable confusion.

Other discussions of the rationale for the fading of response prompts are difficult to find. In Chapter 7, we shall re-consider the issue and offer a rationale which is based on the cognitive account of learning.

**Spurious Prompts**

If prompts which elicit the overt response by spurious means are to
be effective, then the basis for making that response must at some point be transferred from the spurious to the relevant (Schusterman, 1966). Can fading facilitate this transfer? Presumably it can if the prompt which serves as the substitute is a non-spurious one (or even a potentially spurious one which is less likely to encourage reliance on the spurious basis for responding), since this may induce the learner to emit the response on the basis of the relevant information. Indeed, it is likely that we can explain in this way the results of Studies 3 and 4 (Section 5.2), in which an improvement in performance followed the replacement of a prompt which probably functioned spuriously (full physical guidance) with ones which could not, or were less likely to, function spuriously (stimulus, verbal and gestural). However, this would not count as an example of fading as we have defined it (p.145), in that the replacement prompts were not intended to be less controlling. The question arises, then, whether fading as defined can facilitate the move from the spurious to the relevant basis.

Schusterman (1966) offered an account based on the selective attention research (p.31), and specifically the finding that other features in a compound stimulus are more likely to gain some control if the control initially exercised by the main feature is relatively weak (Sutherland & Holgate, 1966; Sutherland & Mackintosh, 1971; Dickinson, 1980). Put another way, this finding suggests that, in the absence of any strong initial control being exercised by one of the features, the learner is likely to attend to more of the features, and thereby more of the features are likely to gain some control. In the absence of any control by the natural antecedents, a prompt will typically be required in the initial stages of teaching which exercises strong control. This can be seen as analogous to the selective attention situation in which strong initial control is exerted by one of the features. On the basis of this analogy, we could then suggest that, because of the strong control exerted by the prompt, the learner is less likely to attend to the other features in the learning situation which include the natural antecedents. Accordingly, the natural antecedents are less likely to gain any control. If, however, we were then to reduce the control exercised by the prompt, then the situation may become analogous to the situation in the selective attention paradigm in which none of the features exercises strong control. In the latter situation, the learner
is likely to attend to more of the features, and thereby more of the features are likely to gain some control. If the analogy is appropriate, we would then expect that, as the control exercised by the prompt is reduced, the learner is more likely to attend to the other stimuli, including the natural antecedents, which are accordingly more likely to gain control.

A serious difficulty facing this account is whether the analogy between the selective attention studies and the use of prompts is a valid one (cf. p.32). For whereas the faded prompt has a history of exercising strong control, no stimulus has such a history in the selective attention situation in which there is no strong initial control. This difference may be critical. Dickinson (1980) offers a cognitive explanation for the finding that selective attention is more likely to occur when one of the features exercises strong initial control: Such a feature strongly predicts reinforcement and other features in the compound provide no additional information about the occurrence of reinforcement. Therefore, in terms of obtaining reinforcement, there is no advantage to be gained by attending to the other features. By contrast, in the more uncertain situation in which no feature exercises significant initial control and therefore no feature is strongly predictive of reinforcement, it will be more adaptive for the learner to attend to the several features. If this is correct, then the situation in which a faded prompt is being used is not analogous. For the prompt, even though it is in a faded form, may nevertheless be strongly predictive of reinforcement because of its history.

The cognitive approach can also be used to derive an alternative rationale for the fading of spurious prompts. Quite simply, the fading of the prompt may indicate to the learner that the prompt is, indeed, being withdrawn. The realization of this may induce the learner to search for an alternative basis for making the response. The learner may be more likely to determine the required information in this search than during no-prompt training. For the prompt, though spurious, will often contain at least some of the relevant information which may, in turn, assist the search. For example, though the prompt may not provide information about the discriminating features of the relevant stimulus, it may nevertheless indicate the identity of that stimulus, the knowledge.
of which can presumably increase the probability of the learner determining its relevant features (p.22).

There are some other points of interest to be considered. First, it will recalled that Skinner claimed that, unless the control of the initial prompt is reduced, then the natural antecedents will gain no control and no learning will occur (p.149). There are several theoretical arguments that can be brought against this claim. For example, with reference to stimulus prompts, we argued that the acquired response to a prompted form of the stimulus will generalize to another form if the two forms are sufficiently close for stimulus generalization to occur. An implication of this is that, if the initial prompted form version and the criterion form are sufficiently close for generalization to occur, then the response will occur to the criterion form even without an intermediate fading series (p.146). Another argument against it concerns response prompts. An assumption of the behavioural framework is that attention to an antecedent in the context of the reinforcement of the overt response will result in the reinforcement of that attentional behaviour, and thereby an increase in the control exercised by the antecedent over the response (p.19). Since response prompts (at least those which are not operating in a spurious manner) have their effect by controlling an attentional response to the natural antecedent (p.70), then, when the overt response is reinforced, the natural antecedent should gain some control whatever the strength of the control exercised by the prompt. A second point of some interest is that since fading involves a reduction in the control exercised by the prompt, then, relative to a procedure which does not fade the prompt, the probability of errors occurring may be increased. Given that errors may actively impair learning (Section 6.6), it follows that there may be circumstances in which fading is countereffective.

6.1.2: Evidence of Effectiveness

Dorry and Zeaman (1973, 1975) provided evidence for the effectiveness of fading spurious prompts. They used pictures of the relevant object as prompts in teaching the sight-reading of words to children with learning disabilities. If the prompt had any effect in eliciting the overt response, then it would have been on the basis of recognizing the picture
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(a spurious means) rather than the words (the relevant means). In both studies, the group which continued to receive the picture at full illumination throughout the training (i.e. no fading) performed less well, once the prompts were withdrawn, than the group which received the pictures at gradually decreasing levels of illumination. Terrace (1963b), in teaching a choice discrimination task to pigeons, also found that the fading of a spurious prompt along the dimension of luminance was more effective than its abrupt withdrawal. However, the study does not offer clear evidence for the effectiveness of fading in that the two groups did not receive the same number of training trials, and this inequality may have produced the difference in performance. The same problem complicates interpretation of two studies which found that, in teaching stimulus discriminations to children without learning disabilities, large leaps in a fading series were less effective than more gradual transitions (Hively, 1962; Moore and Goldiamond, 1964). Gollin and Savoy (1968), who also taught discriminations to children without learning disabilities, equated the number of trials and observed no difference between the standard fading in of the S- and an abridged programme in which every other step was omitted.

Evidence relating to non-spurious stimulus and response prompts is more difficult to find. Lawrence (1952) taught a discrimination to rats using non-spurious stimulus prompts and found that a group which went directly from the easiest version to the criterion version (i.e. no fading) performed less effectively than a group which went through two intermediate versions, even though both groups received the same number of trials. With respect to response prompts, it is difficult to find any study which has tested the effectiveness of fading. The lack of evidence relating to the effectiveness of fading has been noted by others (e.g. Rilling, 1977; Striefel & Owens, 1980).

In the previous section (p.153), we cast theoretical doubt on Skinner's claim that learning cannot occur unless the control of the prompts is reduced. There is also some empirical evidence against it. Several studies using stimulus prompts in discrimination training have observed that the provision of unfaded prompts was more effective than no-prompt training (Lawrence, 1952 (rats); North, 1959 (rats); Spiker, 1959 (pre-school children)). Moreover, there is a large body of evidence
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demonstrating that giving a full prompt before the learner can make a response can be more effective than giving the same prompt after a response has been made (Cook & Spitzer, 1960; Sidowski et al., 1961; Cook, 1963; Greene, 1966 - see Section 6.5). If we make the (reasonable) assumption that the post-response prompting would have been at least as effective as no-prompt training, then these studies also provide some evidence of the effectiveness of unfaded prompts.

6.1.3: Determinants of Variation in Effect - Formal Factors

This section considers the different procedures whereby prompts can be faded and the difference in content that may occur in the fading series of prompts (the 'prompt hierarchy'). In both cases, the concern is to isolate those formal factors which may determine their effect.

The Method of Fading

The two most frequently used methods of fading are 'increasing assistance' (IA) and 'decreasing assistance' (DA) (Billingsley & Romer, 1983; Wolery & Gast, 1984; Schoen, 1986). Though both are commonly used with response prompts, the use of IA with stimulus prompts is rarely reported. In the IA method, the task is presented and typically, though not always, the learner is given a few seconds to make the response independently. If the correct response is not forthcoming, the least controlling prompt in the hierarchy is then given. If this fails, the next prompt in the hierarchy is given. This continues until, if required, the most controlling prompt is given. In the DA method, the task is presented and the learner is immediately given the most controlling prompt in the hierarchy (or, in the case of stimulus prompts, the easiest version of the task). Trials continue in this format until some pre-determined criterion of performance is reached. At this point the learner is presented with the next prompt in the hierarchy (the next easiest version). This continues until the least controlling prompt is presented. If the learner fails to perform the correct response, then the prompt from the previous level is presented and trials continue at that level until the pre-determined criterion is again reached.

The main advantage of the DA procedure is that it minimizes the risk
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of errors and the countereffects thereof (Striefel & Owens, 1980; Billingsley & Romer, 1983). We shall consider the importance of avoiding errors in Section 6.4. The disadvantage of the method is that it risks 'overprompting' the learner and thereby reducing efficiency and even, perhaps, effectiveness1. For under the method the learner could continue to be prompted even though, given the opportunity, they could perform the task without assistance. Moreover, they could continue to be given a less faded prompt even though, given the opportunity, they could perform it with a more faded prompt. On the assumption that fading can facilitate acquisition, this too may reduce efficiency. Overprompting may also have motivational countereffects. Being given too much help may result in a loss of interest and motivation. Indeed, Hively (1962), in teaching children a discrimination task, found that a group who had twice as many trials at each stage in the fading series performed less well than a standard group. He attributed this to a loss of interest in the task on the part of the former group because of the insufficient challenge posed by the many trials at each stage. Other researchers have provided anecdotal evidence of the boredom and consequent deterioration in performance that can result from overprompting (Fitzgibbon, 1965; Aiken & Lau, 1967). A related finding from animal research is that extensive prior training on the $S+$ alone can interfere with the effectiveness of later discrimination training (Skinner, 1938; Terrace, 1963a).

The advantage of the IA procedure is that it gives the learner sufficient opportunity to respond without assistance or with the help of less controlling prompts, and thereby avoids the risk of overprompting (Walls et al., 1981; Wolery & Gast, 1984). Conversely, the risk of errors is increased (Staige et al., 1987). Some other potential disadvantages have also been suggested:

1. Falvey et al. (1980, p.111) suggest that: "Extensive use of this procedure [IA] can be expected to teach students that there is no reason to respond to an initial cue since eventually they will be physically guided through the desired response."

1 It will be recalled that effectiveness refers to the probability of acquisition, and efficiency to its speed - see p.14.
They do not elaborate on this, but presumably their suggestion is that the learner, realising that a fully controlling response will eventually be given, prefers to wait for that prompt rather than expending any effort on learning the task, or running the risk of making an error. Though this may occasionally be so, it overstates the case to say that this 'can be expected' to occur. It seems likely that, for many learners in many circumstances, the motivation to perform the response without assistance and to obtain the reinforcement as soon as possible, will outweigh any wish to avoid making errors or expending effort. Moreover, it could be argued that the same difficulty might arise with the DA procedure, since it too provides more controlling prompts as back-up. In both cases, the problem might be reduced by not reinforcing responses elicited by the most controlling prompt (see Section 6.4.4).

2. Wolery and Gast (1984, p.62) suggest that:
"...incorrect application of the procedure may result in the subject learning that errors must be performed prior to reinforcement.".
Similarly, Doyle et al (1988, p.38) suggest that the procedure:
"...may teach students that reinforcement will occur only after several incorrect responses or waits are performed prior to the correct response."
Neither set of authors elaborates on their suggestion. However, what they may have in mind is an analogy with the chaining paradigm (cf. p.47 and Section 6.6) in which the subject learns to make a response in order to bring about presentation of a discriminative stimulus for a second response, which in turn either brings about another discriminative stimulus or the primary reinforcer. Applying this to the IA procedure, the suggestion may be that the subject learns to wait or make an error in order to bring about the presentation of a prompt which acts as a cue for the correct response. However, the analogy is rather tenuous. In the backward chaining paradigm, the learner can only obtain the primary reinforcer by means of a series of responses; in the IA paradigm, the learner can obtain it immediately on presentation of the task or at any time thereafter. If we adopt the cognitive perspective, then we can see that this difference is probably critical in many cases: Many learners will presumably appreciate in the IA paradigm that they can obtain the primary reinforcer whenever the task materials are presented and will respond accordingly. Moreover, it could again be argued that the same
difficulty might arise when the DA procedure is used, and that the likelihood of its occurrence can be reduced by not reinforcing responses elicited by the most controlling prompt.

3. The method may involve a significant period of time between the initial presentation of the natural antecedents and the presentation of the controlling response, which period may be filled with the presentation of several non-functional prompts. This has several potential disadvantages. There may be an adverse effect on motivation. The delay and the non-functionality of the prompts present the learner with evidence of their own lack of ability (cf. Study 11 in Chapter 8), and the learner may be frustrated by the enforced wait for reinforcement. Doyle et al. (1988) also suggest that time is wasted by the presentation of several non-functional prompts, thereby reducing efficiency. Gentry et al. (1979, cited by Csapo, 1981) suggest that the delay will prevent the temporal contiguity between the natural antecedent and the response which is necessary for the antecedent to gain any control. However, what is presumably necessary if the antecedent is to gain control is temporal contiguity between attention to the antecedent and the correct response, rather than between the initial presentation of the antecedent and the response. This implies that the delay introduced by the procedure will disrupt learning only if, for some reason, the learner is not attending to the natural antecedent at the time of making the overt response. This may be particularly likely to occur if the antecedent is a stimulus of brief duration which does not persist until the response is made. An important example of such an antecedent may often occur in chained responses. In Chapter 2 (p.47) we suggested that the most important discriminative stimulus for a response in a chain is often the preceding response, which, of course, often constitutes a stimulus of brief duration which cannot persist until the subsequent response is made. Another important example of brief non-persistent antecedent are verbal stimuli. Cook and Spitzer (1960), in teaching paired-associates, found that an immediate presentation of the response term (the prompt) produced better learning than a delayed presentation.

The IA and the DA procedures, then, have opposing advantages and disadvantages. Accordingly, in some circumstances it might prove more efficient, or even more effective, to use procedures which combine
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elements of both. Various options suggest themselves. One possibility
would be to begin with the DA procedure and then to introduce the IA
procedure at a later point in training (Csapo, 1981). The rationale for
this is that errors are presumably more likely in the earlier stages of
learning, so that the IA procedure is more likely to produce errors if
used early and the DA procedure is more likely to overprompt in the later
stages. We might also consider using the DA procedure to teach those
steps of a task which the learner is likely to find difficult to acquire
(and therefore may make too many errors if the IA procedure were used),
but the IA procedure for the easier steps (for which there would be a
significant risk of overprompting if the DA procedure were used) (Cuvo et
al., 1978). Another option would be to incorporate within the DA
procedure probe trials of the type used in the IA procedure. These probe
trials would indicate what level of prompt was required, and indeed
whether any prompt at all was required. Such a procedure would reduce
any risk there was of overprompting, but would carry less risk of errors
than the IA procedure. A third option would be to fade prompts across
trials in accordance with some performance criterion (as in the DA
procedure), but within each trial to give the learner the opportunity to
respond without assistance or with a less controlling prompt. Steege et
al. (1987) provided an example of such a procedure. For each task step,
the learner was first given the opportunity to respond without a prompt.
If the correct response was not given, the teacher then gave a prompt
from the level just below (i.e. less controlling than) the prompt that
had elicited the correct prompt on the previous trial. If this too
failed to elicit the correct response, then the latter, more controlling
prompt was given. Steege et al. compared this procedure to a standard IA
procedure and found it to be more efficient in terms of trials to
criterion and duration of training for all four of the participants.

It should be emphasized that the suggestion is only that there may be
some circumstances in which these compromise procedures will be more
efficient/effective than the IA or DA procedures. In other
circumstances, the IA or the DA procedure may be the most efficient/
effective. The relative efficiency/effectiveness of procedures will
depend on the relative probabilities of the occurrence of errors and
their countereffects, the occurrence of overprompting and its
countereffects, and the occurrence of the other problems associated with
the use of the IA procedure. These probabilities will, in turn, depend on circumstantial factors, which we shall consider in the next section. Thus, for example, if there is a high risk that any errors will have a significant countereffect on learning, then the DA procedure may be more efficient and effective than any of the intermediate procedures.

The same considerations apply when considering the relative efficiency and effectiveness of the IA and the DA procedures. In some circumstances the IA procedure is likely to be more efficient/effective (e.g. when the learner requires only minimal assistance to acquire the skill), but in other circumstances the DA procedure is likely to be so (e.g. when there is a high risk that errors will have a countereffect on learning). This point should be borne in mind when considering the empirical comparisons that have been made between the two procedures. The conclusions should be restricted to circumstances which are similar to those of the study and we should avoid the general conclusion that one procedure is more efficient than the other (i.e. that is has universal or overall superiority - p.13).

Comparative studies of the two procedures are, in any case, rather scarce (Billingsley & Romer, 1983; Schoen, 1986). Gentry et al. (1979, cited by Csapo, 1981), in teaching a colour discrimination to learners with severe or profound learning disabilities, found that the DA procedure produced a more accurate level of performance than the IA procedure. There are also a number of studies (Walls et al., 1981; Denchak, 1989) which have compared the IA procedure with 'graduated guidance', which, at least as normally applied, is a form of the DA procedure which uses only various forms of physical guidance. No clear differences emerged. Interpretation of these studies is, in any case, problematic, since the compared strategies differed not only in the fading procedure, but also in the content of the prompt hierarchies that they employed.

In selecting, then, from the procedures that we have considered, it will be necessary to balance the need to avoid overprompting against the need to avoid errors and the other potential problems of the IA procedure. Such a balance is also required in tackling other procedural decisions - such as how many steps one should include in the fading.
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series and, in the case of the DA procedure, how many trials should be
given on each step (i.e. what performance criterion should be set for
progression to the next level of prompt - p.155). Too much training on
each step will lead to overprompting (Hively, 1962 - p.156), but too
little may lead to errors. Likewise, including too many steps in the
fading series will lead to overprompting (Schusterman, 1966), but
including too few will lead to errors (Hively, 1962; Moore & Goldiamond,
1964 - p.154). Including too many prompt types in the IA hierarchy is
also problematic in that it may increase the number of non-functional
prompts that are presented between the antecedent and the correct
response (p.158).

The Content of the Hierarchy

In deciding on the content of a fading series of prompts, we should
be guided by the rationale for fading the particular type of prompt being
used. The rationale provides an account of the mechanism whereby fading
may have an effect and the content of the series should be such as to
maximize the probability that that mechanism will be operative.
Accordingly, in this section we shall consider the implications of each
rationale for the content of the hierarchy; what contents have been used
or suggested in existing research; how well the content implied by the
rationale matches that used or suggested in the existing research; and
certain other objections that have been raised against particular
practices.

In discussing the rationale for fading, we gave separate
consideration to stimulus, response and spurious prompts. The rationale
we offered for spurious prompts implies that the fading should indicate
to the learner that the prompt is, indeed, being faded (p.152) and that
therefore they must determine the relevant basis for making the response.
Selection of the content of the series should accordingly be guided by
this consideration. In practice, spurious prompts are typically faded in
the same way as non-spurious stimulus or response prompts. Presumably,
this, in itself, will sometimes provide sufficient indication to the
learner that the prompt is being removed and an alternative basis for
making the response must be found. However, Engelmann and Carnine (1982)
suggested taking more direct measures to encourage this realization.
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With reference to the fading of potentially spurious stimulus prompts, they proposed that, instead of a gradual progression from the easiest prompted version to the criterion version, the latter should be presented at regular intervals throughout training, with approximate responses being sufficient (at least in the early stages) to ensure reinforcement. The rationale for this arrangement is that it would help the learner to realise that some of the alternative methods of completing the prompted versions cannot be transferred to the criterion task, and that they must therefore select a method of completing the criterion task which will transfer. There are several issues raised by this proposed solution. First, it presumably requires a significant degree of intellectual ability to realise that only some methods are effective for both the prompted and the criterion versions. The solution may not be appropriate for those with more severe learning disabilities. Second, it is not clear that their solution would be adequate if the learner was unable to perform the criterion version even in an approximate way. For if this were the case, the learner would presumably be unable to determine which methods were applicable to both the prompted and the criterion versions. Finally, there are alternative solutions worth pursuing, the most obvious of which is to try to ensure that the prompts do not permit a method of completing the task which is essentially different from that required on the criterion version (i.e. to ensure that the prompts are not spurious).

In respect of the application of non-spurious stimulus prompts to teaching about the stimulus or goal, the rationale for fading was offered in terms of stimulus generalization (p.146). The implication of this for the content of a fading series is that each step in the series should bring the form of the stimuli closer to their criterion form. Applications of this type of prompt in existing research have generally conformed with this implication. With respect to applications of stimulus prompts to teaching the response component, we suggested two cases in which fading might be effective - when the learner needs to practise the response, and when the task alterations have obscured the relevant features of the stimuli (p.149). In the latter case, the rationale was given in terms of stimulus generalization, and this implies the same type of content for the fading series as that suggested for the application of stimulus prompts to teaching the stimulus component. In the former case, the rationale was given in terms of the need to ensure...
practice on versions of the task which more closely approximate the criterion task in terms of the degree of power, precision and simultaneous attentional demands that are required (p.148). The implication of this is that the fading series should gradually increase these demands.

Response prompts are more problematic. The rationale for their fading offered by Skinner (1968) was that a reduction in the control of the prompts will lead to an increase in the control of the natural antecedents (p.149). This implies that each prompt in the series should exercise less control than its predecessor. However, as we noted earlier (p.150), Skinner did not provide an analysis of those features of a prompt which determine the degree of control it exercises. Consequently, his account does not provide clear general guidelines about how we should alter or replace a prompt in order to reduce the control it exercises. In other words, it is unclear which factors can be manipulated in order to reduce the control of the prompt. The lack of guidance offered by Skinner's account is evident in the vague and inconsistent nature of the recommendations that have been offered in the existing literature concerning the content of the response prompt hierarchy. It is variously suggested, for example, that each successive prompt in the hierarchy should offer 'less assistance' (Skinner, 1968) or less 'instructional input' (Ford & Mirenda, 1984) or be 'less efficient' (Hourcade, 1988) or 'less intrusive' (Schloss, 1986; Doyle et al., 1988). These terms are vaguely defined, if at all. For example, it is not clear which aspects of a prompt determine its 'intrusiveness', and therefore it is unclear how the next prompt in the series can be made less intrusive. It is also unclear what relationship these different terms have to one another, and to what extent they are consistent with the suggestion that fading should reduce the control of the prompt. Does a less intrusive prompt necessarily offer less assistance and necessarily exercise less control?

In terms of actual prompting practice, one of the most popular methods of fading response prompts is the hierarchy which moves from physical to gestural/modelling to verbal prompts (Doyle et al., 1988). This traditional hierarchy has been criticized (Wilcox & Bellamy, 1982; Billingsley & Romer, 1983; Wolery & Gast, 1984). One of the criticisms relates to the fact that all the prompts in the hierarchy will not be
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suitable for all circumstances. For example, verbal instructions may not be effective for those with a more severe learning disability. The inclusion of ineffective prompts will reduce the efficiency of the procedure (p.158). Another criticism is that it will involve the prompt being given in a sensory modality which is different from the sensory modality of the task component being taught (Billingsley & Romer, 1983; Wolery & Gast, 1984). This criticism is based on the claim that it will be more effective to match the modality of the prompt and the component. This claim was discussed in Chapter 2 (p.58). We found no empirical or theoretical support for it. Certainly, cross-modal prompts can be perfectly effective in many cases in conveying the required information and, in circumstances where this is so, then there is no reason not to use them. Billingsley and Romer (1983) also criticize the traditional hierarchy on the grounds that the transition from one modality of prompt to another may increase the number of errors. This criticism is based on the observation that, in fading stimulus prompts, gradual withdrawal is more effective than abrupt withdrawal (p.154). By analogy, they suggest, abrupt shifts of prompt modality may also increase errors. However, the analogy is of dubious validity. Abrupt transitions in the withdrawal of stimulus prompts will cause errors if the gap between the two values of the variable is too great to be bridged by stimulus generalization (p.146). The transition from one prompt modality to another does not involve stimulus generalization in any way.

A more valid criticism of the traditional hierarchy is that a transition from physical to gestural to verbal prompts does not necessarily guarantee that each subsequent prompt in the series will exercise less control (Wilcox & Bellamy, 1982). For example, a full verbal instruction to a verbally competent learner, or a full model to a learner who is readily able to imitate, may often exercise more control than a partial physical prompt. Indeed, if we take into account the need for the prompt to control the necessary attentional responses, then a full verbal instruction or full model could exercise more control than a full physical prompt (p.133).

Some alternatives to the traditional hierarchy have been suggested. Billingsley and Romer (1983) drew a distinction between symbolic and illustrative prompts. Illustrative prompts provide a picture of the
response and are therefore high in 'iconicity'. Examples include full physical guidance and models. Symbolic prompts provide little or no 'iconicity' or resemblance to the response. Examples include partial physical prompts, verbal instructions and pointing. Symbolic prompts, suggest Billingsley and Romer, provide less assistance. So within the fading series the transition should be from illustrative to symbolic prompts. They point out that the traditional hierarchy often does not conform to this, in that, for example, partial physical prompts (symbolic) are often given earlier than models (illustrative). However, the claim that 'symbolic' prompts provide less assistance (or are less controlling) is questionable. As we noted in the previous paragraph, a full verbal instruction to a verbally competent learner could exercise as much control as a full physical prompt and may even exercise more.

Some researchers have advocated a greater use of within-mode fading for response prompts (Falvey et al., 1980; Wilcox & Bellamy, 1982; Billingsley & Romer, 1983). Wilcox and Bellamy advocate it on the grounds that all the prompts in the traditional hierarchy will not be suitable in all circumstances. For example, as we have already noted, verbal instructions may be ineffective when given to those with more severe learning disabilities (p.164). Billingsley and Romer advocate it on grounds which we have already criticized - namely, that it avoids the cross-modal prompts and shifts involved in the traditional hierarchy. Fading within the physical mode has been popularized by the procedure known as 'graduated guidance' (Azrin & Armstrong, 1973; Demchak, 1989). At least as typically practised, each level in this series does appear to be a less controlling form of physical prompt. Though the use of within-visual and within-verbal hierarchies has occasionally been reported in the literature (e.g. Alper, 1985), such instances are rare.

6.1.4: Determinants of Variation in Effect - Circumstantial Factors

We shall discuss circumstantial factors with reference, in turn, to the rationales for fading, the different procedures and the different contents. A rationale for the fading of non-spurious stimulus prompts was given in terms of stimulus generalization (p.146). A cognitive translation of this can be given in terms of the learner's conceptual system. Individuals with less severe learning disabilities generally
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have more abstract conceptual systems and so are generally capable of stimulus generalization across greater distances. Thus, in some circumstances, the effect of fading these prompts may be less for such learners, and they may require fewer steps in the series. A rationale for the fading of spurious prompts was given in terms of the learner's realization that the prompts are being faded (p.152). Presumably, individuals with less severe learning disabilities are generally more likely to realize this.

With reference to the different procedures, it was suggested that their relative efficiency and effectiveness will depend on the relative probability of the occurrence of errors and their countereffects, the occurrence of overprompting and its countereffects, and the occurrence of the other problems associated with the use of the IA procedure (p.160). These probabilities partly depend, in turn, on circumstantial factors. We shall consider the circumstantial determinants of the countereffects of errors in more detail in Section 6.4. In the present context we may note that some individuals may show an adverse reaction to errors or to delays in reinforcement, in which case it might be preferable to use a procedure which minimizes errors and avoids delays in reinforcement (i.e. decreasing assistance) (Bennett et al., 1986; Demchak, 1989). By contrast, others may show an adverse reaction to overprompting or may be motivated by errors, in which case it might be preferable to use a procedure which maximizes the opportunity to perform with minimal or no assistance (i.e. increasing assistance). Task variables may also be important. We discussed earlier (p.158) the problems that may arise when the IA procedure interposes a delay between the initial presentation of the natural antecedent and the response, and we noted that this disruption of temporal contiguity may be particularly significant in tasks in which the discriminative stimulus is brief and non-persistent (e.g. chained tasks in which the previous response is an important discriminative stimulus for the subsequent response).

The traditional hierarchy for fading response prompts has been criticized on the grounds that all three prompt modalities will not be appropriate for all circumstances (p.163). The discussion in Chapter 2 (p.59) of the individual factors which determine the functionality of response prompts is of relevance here. Thus, for example, some
individuals may find physical guidance aversive and resist it (p.60). Furthermore, for those with more severe learning disabilities, models or verbal instructions may be non-functional and their inclusion in an IA procedure would result in the presentation of several non-functional prompts between the initial presentation of the natural antecedent and the response, which may create problems (p.158) (Wilcox & Bellamy, 1982; Wolery & Gast, 1984; Schoen, 1986). Conversely, if the traditional hierarchy were used in the DA procedure, more able learners would be given unnecessary help in the form of physical guidance and so would be overprompted. These observations have led some researchers to propose that the decreasing assistance procedure should be used for the less able and the increasing assistance procedure for the more able (Wolery & Gast, 1984; Schoen, 1986). However, this confuses the procedural and the content aspects of these strategies. An increasing assistance procedure may include only physical prompts, and a decreasing assistance procedure may include only verbal prompts. Finally, it has been noted that the learning environment may render some prompts non-functional or inapplicable - for example, verbal directions may be ineffective in a noisy community environment (Wilcox & Bellamy, 1982).

6.2: PROMPT DELAY

Prompt delay is a procedure in which the prompt is initially given immediately at the point at which the response can first be made by the learner, but then subsequently is given after a short interval in which the learner is given the opportunity to make the response without a prompt.

6.2.1: The Mechanism of Effect

There appear to be few discussions in the existing research of the processes whereby prompt delay can facilitate acquisition. Touchette (1971) observed in a discrimination training study that, as the prompt was further delayed, the participants began to make anticipatory hand movements towards the S+ key before the prompt was presented. He suggested that the delivery of the prompt (consisting of the illumination of the S+ key with red light) served to reinforce these anticipatory responses. Since these responses occurred before the prompt was
presented, they must have been under the control of the natural antecedents. Thus the control of the natural antecedents over the anticipatory movements would have been reinforced and thereby strengthened by the delivery of the prompt. This account is incomplete in several respects. It does not explain why the anticipatory movements began to occur in the first place, nor why the anticipatory movements were subsequently transformed into the actual response. If the prompt is reinforcing, why change the anticipatory response into the full response so that the prompt is no longer given? Most importantly in the present context, it offers no explanation of why delaying the prompt is more effective than continuing to present it immediately.

Charlop et al. (1985) consider prompt delay in the context of the research on selective attention and stimulus overselectivity (cf. Koegel & Rincover, 1976). This research, they claim, indicates that learners with autism are unlikely to attend to both the natural cues and to the prompt when they are presented simultaneously (p.31). However, by presenting the natural antecedents first and then the prompt (which is the effect of delaying the prompt), there is no demand on the learner to attend simultaneously to two aspects of a stimulus complex and so the problem of overselectivity is avoided. On the basis of our earlier discussion of the use of the selective attention research (p.32), we can object to this account. It is questionable whether the analogy between the selective attention paradigm and the use of prompts is a valid one. In the case of non-spurious stimulus prompts, the effect of the prompt requires attention to only one feature (p.69). In the case of response prompts, attention to the prompt, unlike attention to any feature in the selective attention paradigm, will, if the prompt is functional and non-spurious, control an attentional response to the relevant features (p.33, p.70). In the case of spurious prompts, there is empirical evidence for the effectiveness of spurious prompts when used with subjects who would typically show selective attention to just one feature of a compound in the selective attention paradigm, which suggests that there may be critical differences between the two situations (p.34).

Handen and Zane (1987) point out that the use of prompt delay can indicate to the teacher when the natural antecedents have gained sufficient control. Though they note that it may not always be a perfect
indicator of this, certainly it will be a better indicator than the
continued immediate presentation of the prompt. This gives it an
advantage over the latter procedure in that it helps reduce the risk of
overprompting and the countereffects that may spring from this (p.156).

It should be noted that this putative advantage of fading concerns the
teacher's knowledge of when the natural cues have gained sufficient
control. The account does not suggest any direct mechanism whereby delay
can facilitate acquisition.

Prompt delay may, in fact, facilitate acquisition in the same way as
the fading of response prompts. Unless the learner makes the correct
response before the prompt is given, delaying the prompt involves a delay
in reinforcement. The frustration of waiting for the reinforcement may
encourage the learner to make unprompted responses (cf. Walls et al.,
1982). If those responses are correct, then the control exercised by the
prompt in their elicitation will have been reduced (or, more precisely,
eliminated). A reduction in the control exercised by the prompt is also
the means whereby, according to Skinner, the fading of response prompts
can facilitate acquisition (p.149). However, an explanation of how the
reduction in prompt control can achieve this end has not been forthcoming
in the existing research (p.150). We shall offer an account from the
cognitive perspective in the next chapter. This will apply to the fading
and delay of both stimulus and response prompts, whether spurious or non-
spurious.

We should also note that since it gives the learner the opportunity
to make errors, delaying the prompt may, like fading (p.153), increases
the probability of errors relative to not delaying, and therefore it may,
in some circumstances, be less effective than not delaying.

6.2.2: Evidence of Effectiveness

In reviewing the evidence for the effectiveness of prompt delay, we
are confronted with a familiar picture. To demonstrate its effectiveness
it is necessary to compare a strategy which includes delay with another
strategy which does not include it (i.e. the prompts are presented
immediately) but is otherwise identical (p.11). There are innumerable
studies which have reported the successful acquisition of a skill
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following the application of a prompting strategy which included prompt delay (for reviews, see Handen & Zane, 1987; Striefel & Owens, 1980; Billingsley & Romer, 1983; Wolery & Gast, 1984; Schoen, 1986). However, few, if any, of these studies have included the appropriate experimental control to ensure that the effect was attributable only to the inclusion of delaying the prompt in the strategy (Handen & Zane, 1987). Indeed, Handen and Zane point out that in some studies successful unprompted performance of the task occurred on the first trial after the delay was introduced (e.g. Striefel et al., 1974) - which indicates that the learning took place before the delay was introduced. Handen and Zane note that some studies did include a reinforced baseline, but that most of these did not extend the baseline sufficiently for it to constitute an appropriate experimental control. An exception was provided by two studies by Halle and his colleagues (Halle et al., 1979 and 1981). Since there was an improvement in performance following the introduction of prompt delay in these studies, Handen and Zane offer them as limited support for the effectiveness of the procedure. However, their offer must be rejected. The appropriate experimental control for testing the effectiveness of delaying the prompt is a condition in which the prompt is not delayed but which is otherwise identical. In the studies by Halle and his colleagues, the baselines consisted of unprompted trial-and-error training. The improvement in performance following the introduction of the prompting strategy may have been due to the introduction of prompts, rather than the introduction of prompt delay.

6.2.3: Determinants of Variation in Effect - Formal Factors

There are various ways in which the delay procedure can vary, and there is some theoretical discussion and empirical evidence in the existing literature concerning the effects of these formal variations. When considering these variations, it is useful in this context to recall the discussion about the related merits of the increasing and decreasing assistance procedures, and the need, on the one hand, to avoid overprompting and, on the other, to avoid errors and the other problems associated with the increasing assistance procedure (p.160).
Size of Increments in Progressive Delay

Walls et al. (1982), in teaching assembly tasks to people with learning disabilities, compared increments of 1, 3 and 5 seconds, and found that the 1-second increments resulted in fewer errors during training and significantly fewer trials to criterion. They suggested that the larger increments permitted unprompted responses to occur earlier in training when errors were more likely, and that, because of the relatively lengthy and frustrating wait for reinforcement that could be involved in the use of longer increments (in their study, the 5-second increment involved waits of 15 seconds or more), the longer increments offered more encouragement to the learners to make unprompted responses. Accordingly, they suggest, errors before the prompt was given were more likely when the larger increments were used, and the errors interfered with acquisition. We might also add to this that the longer increments may have resulted in longer periods between the initial presentation of the natural cues and the correct response, which may, in turn, have led to frustration and a disruption of the required temporal contiguity between attention to the natural cues and the emission of the correct response (p.158). The latter factor may have had a particularly disruptive effect on the acquisition of the chained tasks used in the study, since each response in the chain may have been an important discriminative stimulus for the subsequent response (p.158). This factor also needs to be considered in other tasks in which the natural discriminative stimuli are brief and non-persistent (p.158). On the other hand, we cannot infer any overall superiority (p.13) for smaller increments on the basis of the study by Walls et al. For, although larger increments increase the risk of incorrect responses occurring before the prompt in the early stages of learning, by the same token they also increase the chances of correct responses occurring before the prompt in the early stages of training. Hence they carry less risk of overprompting, and we might expect them to be more efficient in those circumstances in which the risks of overprompting outweigh other considerations.

Limiting the Delay

The problems associated with long periods between the initial
presentation of the natural cues and the correct response also suggest a relative advantage for placing an upper limit on the amount of time provided by the delay procedure before the prompt is delivered. Billingsley and Romer (1983) also suggest that long delays may result in the participant learning to perform chained tasks in such a way that they interpose long delays between each step. This would constitute an obvious disadvantage in the performance of many chained tasks, particularly in natural settings. Billingsley and Romer offer no justification for their suggestion. However, it may be that the procedure would fail to instil in the learner the importance of responding rapidly. As with manipulations of the size of increments, it is difficult to claim any overall superiority for limiting the delay. There may be an advantage in some circumstances in allowing relatively lengthy delays for reasons which will become clear when we discuss the rationale for delaying the prompt from the cognitive perspective.

Progressive versus Constant Delay

In the constant delay procedure, the length of the delay is constant throughout training; in Progressive Delay, it is increased gradually by a set increment. Handen and Zane (1987) compared a maximum of 24 studies which had used either progressive or constant delay on various indices of effectiveness and efficiency. In terms of group means, the progressive procedure was better on two of these indices but worse on another. However, the comparison needs to be treated with caution for methodological reasons. It seems unlikely that the effects of determining factors other than the progressive-constant variable were randomized or held constant in the sample. In a direct comparison, Ault et al. (1988) found no difference in efficiency between the two variants of the procedure in teaching sight reading. Theoretical discussions of the relative merits of the two variants are difficult to find in the existing research. Like progressive delay with large increments, constant delay may in some circumstances lead to more pre-prompt errors earlier in training than progressive delay with smaller increments, but in other circumstances may run less risk of overprompting than the latter procedure.
Performance Criteria for Increasing/Introducing Delay

Procedural variation is possible in terms of how many correct trials are required before the delay is introduced or increased. A similar issue arose in relation to the decreasing assistance procedure (p.161). The learner will be overprompted if too many trials give no opportunity to perform unassisted, but too few such trials may lead to errors. To some extent, the risks of errors may be reduced by the procedure of moving back to the previous level of prompt when an error is made, which will be discussed in the section on errors (6.4).

6.2.4: Determinants of Variation in Effect - Circumstantial Factors

The delay procedure and the increasing assistance procedure have in common the fact that both provide the learner with the opportunity to respond with little or no assistance. This has the advantage of reducing the risks of overprompting (p.156). In the case of the increasing assistance procedure, this advantage is bought at the cost of increasing the risk of errors and of disrupting the temporal contiguity between attention to the natural cues and the performance of the correct response (p.158). The same applies to prompt delay. The risk of errors and temporal disruption is increased when the prompt is delayed relative to when it is not delayed. (Indeed, although prompt delay is often included as an example of 'errorless' learning, significant error rates (10% or more) are not uncommon (Handen & Zane, 1987).) This similarity between increasing assistance and prompt delay relieves us of the need to list in detail the circumstantial factors which may cause variation in the effect of prompt delay. For these will be similar to those listed in connection with the effect of increasing assistance (p.166). Presumably, too, any variation in the relative effectiveness of the different variants of the Delay procedure will depend on the same factors. It will be sufficient, then, to confine our discussion to some relevant points that have been made in the existing research.

With respect to task variables, several researchers have noted that the vast majority of reported applications of prompt delay have been to the teaching of discrete rather than chained responses (Billingsley & Romer, 1983; McDonnell, 1987; Handen & Zane, 1987; Schuster et al.,
Furthermore, even when they have been applied to the teaching of chained tasks (Snell, 1982; Walls et al., 1982 and 1984; McDonnell, 1987; Schuster et al., 1988), the tasks have been composed of relatively discrete steps (e.g. shopping) and it is difficult to find examples of the procedure's application to chained responses in which each response in the chain is likely to be an important discriminative stimulus for the next response - for example, those in which there is no external stimulus which reliably indicates when the response is required (e.g. executing a set sequence of dance steps). This is interesting in view of our suggestion that disrupting the temporal contiguity between the responses in such chains may interfere with acquisition (p.158).

Striefel and Owens (1980) discuss the importance of individual variables. They note that some individuals may anticipate the prompt with many errors rather than waiting (e.g. Snell & Kneedler, 1978). Errors may disrupt learning more than waiting (Section 6.4). It becomes important, then, to consider why some learners do this. It may be that they find the delays in reinforcement frustrating (p.158). Another possibility is that they learn a chained response in which the error forms a part. Given our previous discussion of this possibility (p.157), it may be suggested that individuals with more severe learning disabilities are more likely to do this. In this context it is relevant to note that reports of the use of prompt delay in teaching those with profound learning disabilities are very few. Handen and Zane (1987), in their general review of the research on prompt delay, report only three (Striefel et al., 1974; Halle et al., 1979; Smeets & Striefel, 1980). In all three studies the teaching target appears to have been the increase of the use of an existing skill rather than the acquisition of a new skill. Finally, Steele (1977, cited by Striefel & Owens, 1980) suggested that some learners may respond immediately with an error rather than wait for the prompt because they have no history of delayed reinforcement. Gast et al. (1991) made the related observation that, in learning a series of tasks by means of prompt delay, the participants in their study tended to learn the tasks which appeared later in the series at a faster rate. They suggested that familiarity with a procedure may be an important determinant of its effect.

Striefel and Owens (1980) also observe that some individuals always
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wait for the prompt to be given. This will presumably render the delay ineffective, since its effects rely on the elicitation of unassisted responses (p.169). The lack of responsiveness may be due to a lack of self-confidence and an overdependency on external assistance (p.79), or to a failure to understand that reinforcement can be obtained prior to the presentation of the prompt.

6.3: THE RELATIVE MERITS OF DELAY AND FADING

In recent years, significant research effort has been devoted to empirical comparisons of the relative effects of delay and fading. This section considers the issue from a theoretical perspective, and reviews the empirical evidence.

6.3.1: Theory

Despite the effort that has gone into the empirical comparisons, there are few theoretical discussions of the issue. In one of the more detailed discussions, McDonnell (1987) suggests two advantages that delay has over the increasing assistance procedure. First, he suggests that the attentional value of the prompts will be relatively high when increasing assistance is used because different forms of prompt are given within each trial and changing stimuli have a high probability of being attended (cf. p.97). (We may add that when decreasing assistance is used, the prompts change across trials and again, by this account, the change may increase the attentional value of the prompts.) This creates a problem, McDonnell suggests, because when the attentional value of the prompts is increased, the attentional value of the natural cues is thereby decreased. Prompt delay, on the other hand, has an advantage in this respect because the form of the prompt remains constant throughout training. Second, McDonnell states that when the increasing assistance procedure is used (1987, p.227-228):

"By differentially reinforcing the student's response following the teacher's prompt, the probability that the prompt will come to control the response increases with each successive trial. The functional outcome is that irrelevant stimulus control of the student's response is established, and transfer of stimulus control to the task stimulus is made more difficult."
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By contrast, when prompt delay is used, he maintains, it leads to correct responding immediately following the presentation of the actual task stimulus. This reduces the probability that irrelevant stimulus control will be established and thereby increases the probability that the natural cues will gain control.

Several objections can be raised against these arguments. The first argument cannot apply to the use of non-spurious stimulus prompts, since either the prompt and the natural antecedents are not distinct features, or the effect of the prompt is not dependent on the learner attending to it (p.20)\(^1\). In respect of non-spurious response prompts, we can fault the argument for its assumption that a high probability of attention to the prompt necessarily entails a low probability of attention to the natural cues. As we have had frequent cause to note (e.g. p.70), attention to a functional non-spurious response prompt controls an attentional response to the relevant features. A high probability of attention to the prompt should therefore entail a high probability of attention to the natural cues. In respect of spurious prompts, a high probability of attention to the prompt may, indeed, entail a low probability of attention to the natural cues. However, this is equally true of the use of prompt delay. Furthermore, the fading of prompts may involve a reduction in their attentional value (e.g. the fading of stimulus prompts along the dimension of luminance) which may compensate for any increase in attentional value arising from the change in prompt form. Indeed, it is questionable whether this latter increase will be of any real significance. In the increasing assistance procedure, although there is a change within each trial, the same change occurs in every trial and it may be that the learner comes to expect the change such that it loses its power to attract attention (cf. p.97). In the decreasing assistance procedure, changes in the prompt form occur only occasionally across trials.

McDonnell's second argument is equally questionable. Its assessment is complicated by the fact that it seems to confound two claims. That

\(^1\) The exception are 'directive' prompts (p.20) which, for the convenience of this discussion, can be considered as instances of response prompts.
is, it is not clear whether the alleged disadvantage of fading resides in
the fact that the response follows the prompt, or in the fact that the
response does not immediately follow the presentation of the natural
cues. In any case, both claims are open to question. With respect to
the latter, it is doubtful whether fading is at any intrinsic
disadvantage in this respect. When prompt delay is used, the response
will often not immediately follow the presentation of the natural cues,
and, particularly in the case of decreasing assistance, a fading
procedure may elicit a correct response more rapidly. The other
interpretation of McDonnell's claim (that it is a disadvantage for the
response to follow the prompt) is presumably based on the argument that,
when this occurs, the control of the prompt is thereby strengthened and
this prevents the natural cues gaining any control. This argument can be
countered in the same way as McDonnell's first argument. Thus, it has no
application to non-spurious stimulus prompts since they do not require
attention to a prompt which is distinct from the relevant feature; and,
since attention to functional non-spurious response prompts entails an
attentional response to the natural cues prior to responding, there are
no clear grounds for claiming that the control of the former will be
increased at the expense of the latter gaining any control. The argument
can also be countered on the grounds that the effect of fading (or, at
least, its intended effect) is to reduce the control exercised by the
prompt. Thus any increase in control that accrues to the prompt because
of the reinforcement of the response that follows it, may be more than
compensated for by the decrease in control that results from fading.
Finally, we may question McDonnell's assumption that the correct response
follows the prompt in fading, but anticipates it when delay is used. In
the earlier stages of the delay procedure, the response will, of course,
follow the prompt. By McDonnell's own argument, this should create
difficulties for the procedure.

Other researchers have also asserted the superiority of delay over
fading, but have failed to provide any significant theoretical support
for their claim. For example, Touchette (1971) claimed that when the
delay procedure is used, the response is less likely to remain dependent
on the prompt, but his account (p.167) offers no explanation of why this
might be so. Handen and Zane (1987) repeat Touchette's claim but offer
no further support for it. However, they do offer two additional
arguments in favour of delay. First, they suggest that it is practically superior in that it requires only one form of prompt. In respect of stimulus prompts, this implies less material preparation and therefore less demand on teaching resources (p.77) (Bradley-Johnson et al., 1983). With respect to response prompts, Gast et al. (1988) and Wolery et al. (1990) advocate the use of prompt delay on the grounds that it is easier for teachers to implement because it requires them to make fewer decisions and to give fewer prompts. However, the delay procedure may also involve the teacher in a complicated decision-making process. This may be even more complex than that involved in fading. For example, if progressive delay were applied in teaching a chained task and the learner acquired the different steps of the task at different rates, implementation of the procedure would become exceedingly complex.

The second argument offered by Handen and Zane (and also Bradley-Johnson et al., 1983) is that, in contrast to fading, delay gives the teacher knowledge of the exact moment when the natural cues gain sufficient control over the response, and thereby better avoids the risk of overprompting. However, as they themselves later acknowledge (Handen & Zane, 1987, p.325), this is not always the case. The natural cues may gain sufficient control before the delay is introduced (p.170), and the learner may prefer to wait for the prompt even though, in its absence, they could perform the correct response (p.174). Nevertheless, it could be argued that prompt delay gives a better indication than fading of the point at which the natural cues have gained sufficient control. However, in answer to this, we return to the point made in discussing the circumstantial determinants of prompt delay (p.173). The reduction of the risk of overprompting is bought at the cost of increasing the risk of errors and temporal disruption. Thus it would be unwise to claim overall superiority for delay over fading on the grounds that it effects a greater reduction in the risk of overprompting. It may, indeed, prove superior in circumstances in which the risk of overprompting is high, but it may prove inferior when the risk of the countereffects of errors or temporal disruption is high.

On this basis, we can make a more general point. Because the various risks attached to the withdrawal of prompts are inversely correlated, it seems unwise to claim overall superiority for any one withdrawal
procedure. Delay may, indeed, be superior in some circumstances, but it is likely that there are other circumstances in which it is inferior. It is also unhelpful to make claims to the effect that on average one procedure is superior to another (p.13). This offers little help to the teacher in deciding which procedure is likely to be superior in the particular circumstances under consideration. Rather, we need to specify which procedure is likely to be superior in which circumstances. We have gone some way towards this in our discussions of the circumstances in which the various risks attached to prompt withdrawal are likely to operate (p.165, p.173). For example, we can speculate that the decreasing assistance procedure may be superior when the learner is likely to be frustrated by delays in reinforcement and likely to react poorly to the commission of errors; but that the delay procedure may be superior when the learner is likely to acquire the task rapidly (in which case the decreasing assistance procedure may be likely to overprompt).

Finally in this section, we should note that fading and delay are not mutually exclusive procedures. It is possible both to delay and to fade the prompt. Indeed, many applications of the increasing assistance procedure also incorporate a delay into the strategy (p.155).

6.3.2: Empirical Evidence

The empirical comparisons of prompt delay with fading are summarized in Table 6.1. Information is given about how the procedures compared, in average terms, on measures of effectiveness (whether or not some criterion was achieved) and efficiency (trials or sessions to criterion and amount of direct teaching time - see p.13). Information about the comparative error rate is also included. Most of the cited studies offered this as a measure of efficiency. However, given that efficiency refers to the rate at which learning occurs (p.14), it is misleading to use the error rate in this way. The error rate would only be an accurate measure of efficiency if every error delayed acquisition. As we shall see in Section 6.4, this is a most debatable point. Certainly, the trials to criterion and amount of teaching time are more accurate measures of efficiency. Nevertheless, information about the comparative error rate is useful in selecting a strategy for a particular set of circumstances (which is different from judging average merits). For the
Table 6.1: Summary of Delay-Fading Comparisons

Delay Compared with Decreasing Assistance

<table>
<thead>
<tr>
<th>Study</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bradley-Johnson et al, 1983</td>
<td>PD&gt;DA</td>
<td>(NI)</td>
<td>(NI)</td>
<td>PD&gt;DA</td>
</tr>
<tr>
<td>Miller &amp; Test, 1989</td>
<td>PD=DA</td>
<td>(RT)</td>
<td>(RT)</td>
<td>PD&gt;DA</td>
</tr>
<tr>
<td>Berkowitz, 1990</td>
<td>PD=DA</td>
<td>PD&gt;DA</td>
<td>(NI)</td>
<td>PD&gt;DA</td>
</tr>
</tbody>
</table>

Delay Compared with Increasing Assistance

<table>
<thead>
<tr>
<th>Study</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bennett et al, 1986</td>
<td>PD=IA</td>
<td>PD&gt;IA</td>
<td>PD&gt;IA</td>
<td>PD&gt;IA</td>
</tr>
<tr>
<td>McDonnell, 1987</td>
<td>PD=IA</td>
<td>PD&gt;IA</td>
<td>(NI)</td>
<td>PD&gt;IA</td>
</tr>
<tr>
<td>Godby et al, 1987</td>
<td>PD=IA</td>
<td>PD&gt;IA</td>
<td>PD&gt;IA</td>
<td>PD&gt;IA</td>
</tr>
<tr>
<td>Ault et al, 1988</td>
<td>PD=IA</td>
<td>PD&gt;IA</td>
<td>PD&gt;IA</td>
<td>PD&gt;IA</td>
</tr>
<tr>
<td>Gast et al, 1988</td>
<td>PD=IA</td>
<td>PD&gt;IA</td>
<td>PD&gt;IA</td>
<td>PD&gt;IA</td>
</tr>
<tr>
<td>Schoen &amp; Sivil, 1989</td>
<td>(RT)</td>
<td>(RT)</td>
<td>(RT)</td>
<td>(RT)</td>
</tr>
<tr>
<td>Wolery et al, 1990</td>
<td>PD=IA</td>
<td>PD&gt;IA</td>
<td>PD&gt;IA</td>
<td>PD&gt;IA</td>
</tr>
<tr>
<td>Gast et al, 1991</td>
<td>PD=IA</td>
<td>PD=IA</td>
<td>PD=IA</td>
<td>PD=IA</td>
</tr>
</tbody>
</table>

[PD prompt delay \( > \) superior to
DA decreasing assistance = equivalent to
IA increasing assistance (RT) refer to main text
(NI) no information given in article]

Column 1 concerns effectiveness; column 2 sessions or trials to criterion; column 3 direct teaching time; and column 4 errors.
The participants in the Study by Bradley-Johnson et al. (1983) were pre-school children without a learning disability. This study was also alone in using stimulus, rather than response, prompts.]

the probability of errors having a countereffect will vary according to circumstance - for example, some individuals are more likely than others to show a significant motivational countereffect as a result of making errors (see Section 6.4). In teaching such an individual, it may be better to select a procedure which has a lower rate of errors.
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On the basis of these studies, several researchers have concluded that delay, though no more effective, is more efficient than fading (Wolery & Gast, 1984; Schuster et al., 1988; Schoen, 1986; Miller & Test, 1989). It is not clear whether the claim is that delay has overall superiority (i.e. is never less efficient - p.13) or that it is, on average, more efficient (p.13). In the latter case, the claim is of little value to the user of the technology (p.13), and the studies provide dubious support in that it is unclear that the values taken by the variables in these studies are representative of the populations from which they are sampled. In either case, the evidence provides an insubstantial basis for the conclusion for one or more of the following reasons:

1. In two of the studies, despite the conclusions of their authors, the fading procedure appeared to be superior. Thus Miller and Test (1989) concluded that delay was more efficient than decreasing assistance, but a closer examination of the data they provide indicates that decreasing assistance required, on average, fewer trials to criterion and also less instructional time (though for some reason Miller and Test claim that it required more time). The decreasing assistance did lead to more errors, but we have argued that this should not be used as a measure of efficiency or given equal weight in assessing the relative merits of the procedures. In the study by Schoen and Sivil (1989), contrary to the conclusions of the investigators, the fading procedure was more effective. Whereas all the participants acquired all the task steps under the increasing assistance procedure, one of the participants failed to reach this criterion under the delay procedure. It is also worth noting that, although some of the studies obtained fairly large differences in terms of efficiency (e.g. McDonnell, 1987; Berkowitz, 1990), most observed only small differences (e.g. Godby et al., 1987; Gast et al., 1986; Schoen & Sivil, 1989; Wolery et al., 1990). Indeed, it is not clear that these differences were large enough to be of much practical significance (Miller & Test, 1989).

2. In some of the studies, although the delay procedure was, on average, more efficient, closer analysis of the results reveals that the fading procedure proved more efficient for some of the participants. Thus one of the participants in the study by Gast et al. (1988) and one in the
study by Wolery et al. (1990) learned more efficiently under the increasing assistance procedure.

3. Wolery et al. (1990) conducted maintenance probe trials at 2, 4 and 6 weeks, and retrained the participants on all those tasks on which correct responding was below 80%. Whereas only 4 tasks required retraining following the increasing assistance procedure, 8 tasks required retraining following the delay procedure. Interestingly, Handen and Zane (1987) note that poor maintenance has been reported in several investigations of prompt delay. This raises the possibility that an improvement in the efficiency of learning under prompt delay may be bought at the cost of a decreased level of maintenance. Maintenance must, of course, be taken into account when assessing the relative merits of the two procedures (p.3).

4. None of the studies controlled the effects of other determinants in the comparison. Thus, variation in the type of prompt used will create variation in effect (Chapter 2). In a straight comparison of delay and fading, some variation in prompt type is necessary. However, all the studies involved variation beyond this. For example, most of them used full physical guidance in the fading procedure, but not in the delay procedure. Given the difficulties associated with the use of this type of prompt (p.132), a plausible alternative interpretation of any inferiority of fading in these studies can be offered in terms of the countereffects arising from the use of full physical guidance. Furthermore, in some studies (e.g. Godby et al., 1987) the prompt used in the delay procedure did not appear in the fading series. There are other instances of uncontrolled variation in potentially effective extraneous variables. For example, in some of the studies (McDonnell, 1987; Miller & Test, 1989), in contrast to the delay procedure, the fading procedure was implemented, in all cases, only after the participant had made an error. Post-response prompting may be less effective in some circumstances than pre-response prompting (Section 6.5). Another example is provided in the study of Bradley-Johnson et al. (1983), which used different versions of the discrimination task in the two conditions that were compared. Again, the selection criteria used in the study by Godby et al. (1987) required that the participants waited for the prompt when unsure of their response rather than anticipating it with an error. This
may have excluded from the study participants who were less likely to benefit from the delay procedure (p.174), and may thereby have preferentially favoured this procedure.

5. It is not clear that the studies which showed a superiority for delay used the most efficient or effective fading strategy for the circumstances of the study, in which case it is not clear that the superiority of delay would have been maintained had a superior fading strategy been used. For example, we might question whether the traditional prompt hierarchy (verbal-gestural-physical) used in most of the studies represents the most effective way of decreasing the control of the prompt (p.164). Further, some of the studies reported that their application of the increasing assistance procedure involved the presentation of several non-functional prompts before the controlling prompt was given, and the investigators themselves suggest that it may have proved more efficient had some of these prompts been eliminated (Bennett et al., 1986; Godby et al., 1987 - p.159).

6. All the studies which included the increasing assistance procedure in their comparison combined the components of fading and delay in their increasing assistance strategy (p.155). This implies that any superiority shown by the delay procedure in the comparison must have been due to inadequacies in the increasing assistance strategy, rather than to any positive advantage accruing from the delay component. This feature of the studies also suggests that the concern of the researchers was not to compare two procedural components (delay and fading), but to compare two strategies as they are typically applied. The problems associated with the investigation of composite strategies, rather than individual components, were discussed in Chapter 1 (p.4).

6.4: ERRORS

The avoidance of errors has been a guiding principle in the development of many prompting strategies (Billingsley & Rorer, 1983). In this section we discuss first the difficulties in proving that errors can impair performance (6.4.1). We then consider the ways in which errors might impair learning (6.4.2) and the potential disadvantages of measures to prevent errors (6.4.3). These sections also consider the likely
circumstantial determinants of variations in effect. Finally and briefly, we discuss the issue of how the teaching programme should consequate errors (6.4.4).

6.4.1: Evidence of Effectiveness

Proving that errors can impair performance is difficult. Errors are a dependent variable. To vary the error rate it is therefore necessary to vary an independent variable. Consequently, in studies which compare learning performance under conditions of high and low error, it is never certain whether any variation in learning performance is due to the differential error rate or to variation in the independent variable or to variation in some other consequence of the independent variable. The nature of this methodological problem will become clearer when we consider the evidence that has been offered in support of the claim.

In Chapter 2 (p.17), we noted that there is a considerable amount of evidence showing that stimulus prompts can be more effective than no-prompt training in teaching choice discriminations. The prompt training in these studies typically involved a low rate of errors - so low, in fact, that it is often referred to as 'errorless learning'. This evidence has been offered as support for the claim that errors can impair performance (Hively, 1962; Terrace, 1963a; Sidman & Stoddard, 1967; Touchette, 1968). However, there are clearly alternative ways of explaining the superiority of prompt training. Indeed, an account has been offered in terms of the prompt being more likely to elicit the overt response and the necessary attentional responses to the relevant discriminatory feature (p.19).

Another body of evidence that has been offered in support of the claim concerns the impairment of subsequent discrimination performance that may follow a history of no-prompt training. Thus participants trained to criterion on a discrimination using no-prompt training have shown more post-criterion errors on the discrimination than those trained with prompts (Hively, 1962; Terrace, 1963a; Stoddard & Sidman, 1967; Touchette, 1968). Also, those with a history of failing to acquire the discrimination under no-prompt training have been shown to be less likely to acquire the discrimination when subsequently taught with prompts, than
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those without such a history (Hively, 1962; Sidman & Stockard, 1967; Touchette, 1968; Gold & Barclay, 1973; Schilmoeller et al., 1979; Strand & Morris, 1988). Finally, a history of failed no-prompt training can impair performance on other discrimination tasks, including those previously mastered (Zeaman & House, 1963; Terrace, 1963b). Again, however, alternative explanations of these results are available. For example, in the first two groups of studies, at the point of comparison, those with a history of no-prompt training also had a history of having had more trials on the task; and in all three groups those with the history of no-prompt training may also have expended more concentration and effort on the task. A history of more trials and greater effort may have caused fatigue which, in turn, impaired performance.

Although it may not be possible to prove empirically that errors impair performance, nevertheless we can build up a reasonable case for the claim if we can provide theoretical accounts of how errors may impair performance, and there is empirical and theoretical support for them. These accounts and the relevant support will be discussed in the next section. Though there are some gaps, the empirical evidence offers persuasive, though not conclusive, for the claim.

6.4.2: The Mechanisms of Impairment

Various mechanisms whereby errors might impair learning have been suggested. These can be broadly divided into motivational and performance hypotheses (Hyland, 1981). We give these separate consideration.

Motivational Hypotheses

A frequent suggestion in the research literature is that errors may elicit negative emotional behaviour (aggression, self-injury etc.) and/or a lack of responsiveness which may, in turn, interfere with acquisition (Holland, 1960; Terrace, 1963a; Schusterman, 1966; Koegel & Egel, 1979; Touchette & Howard, 1984). It is clear that a failure to respond will interfere with acquisition (p.18). However, the case of negative emotional behaviour is more complex. Presumably its effect depends on the form it takes. Certain forms will surely interfere (e.g. attempts to
escape the task situation (Carr & Durand, 1985) and other behaviours
which prevent the overt response and the necessary attentional
responses), but it is less certain that other forms will do so (e.g. the
'irritability' reported by Holland (1960)).

Empirical support for the suggestion has been offered in the shape of
reports that errors are often followed by negative emotional behaviour
and a lack of responsiveness. Much of this evidence is merely anecdotal
in nature, in that there was no systematic comparison between the high
and the low error conditions in terms of the frequency of these responses
(e.g. Holland, 1960; Terrace, 1963a; Schusterman, 1966; Berkowitz, 1990).
Some of the evidence does derive from systematic comparisons (e.g.
However, it is unclear from these studies whether the higher rate of
disruption was due to the commission of errors, or to some aspect or
other consequence of the independent variable. For example, the studies
by Weeks and Gaylord-Ross (1981) and by Carr and Durand (1984, 1985)
produced variation in the rate of errors by varying the difficulty of the
task. Carr and Durand (1985) themselves suggest that the greater degree
of disruptive behaviour may have arisen from the greater demands made
during the more difficult task and the greater probability of not
understanding the instructions, rather than the higher rate of errors.

The main theoretical support for the suggestion rests on the
assumption that the failure to obtain reinforcement as a result of errors
functions as an aversive, and therefore punishing, stimulus (Holland,
1960). This has some intuitive plausibility, in that errors may involve
a frustrating wait for reinforcement or, in some procedures, a reduced
frequency of reinforcement, as well as providing the learner with
evidence of their lack of ability (Weeks & Gaylord-Ross, 1981 – p.158).
If this is assumed, then animal research offers some limited support in
that it provides evidence that a history of punishing stimuli, or single
instances of extremely aversive stimuli (e.g. a powerful electric shock),
can elicit negative emotional behaviour (e.g. aggression) (Davey, 1981)).
Punishing stimuli may also, of course, suppress the response on which the
punishment is contingent. By analogy, failure to obtain reinforcement
may suppress the incorrect response. But how will errors lead to a
general lack of responsiveness (including a lack of other attempts to
make the correct response)? The research on learned helplessness has been used to explain this (Koegel & Egel, 1979; Thomas, 1979). Learned helplessness refers to the passivity, lack of general responsiveness and consequent failure to learn to avoid escapable electric shock, that is shown by animals after prior exposure to a series of inescapable shocks (Maier & Seligman, 1976). The phenomenon has also been observed in human subjects (e.g. Thornton & Jacobs, 1971). The human research has also been extended to look at the effects of prolonged failure on insoluble appetitive tasks (e.g. insoluble mathematical problems) - a closer analogy to the occurrence of errors in the prompting situation. Again, it has been observed that this can lead to a reduced rate of responding and reduced persistence on these and subsequent tasks (Dweck & Repucci, 1973; Thomas, 1979).

It is worth emphasizing that the work on learned helplessness suggests that a history of failure may affect performance, not only on the original task, but also on other subsequently presented tasks. Zigler and his colleagues reached similar conclusions from a different theoretical perspective (their work is summarized in Balia & Zigler, 1979). They presented evidence suggesting that people with a learning disability generally have higher expectations of failure, lower expectations of success, a greater reliance on external assistance, and a corresponding greater unwillingness to rely on their own abilities. The effect of these tendencies may be to render the individual more passive and less willing to attempt to complete tasks with little or no assistance. The origins of these tendencies, it is argued, lie in the history of failures and errors that many people with a learning disability have experienced.

The work of Zigler and his colleagues suggests another motivational hypothesis. If there is an unwillingness to rely on one's own abilities and a greater reliance on external assistance, then it may be that the corrective prompts which are typically used after an error have reinforcing properties (Burleigh & Marcholín, 1977; Adams et al., 1981; Liberty et al., 1981; Day, 1987). Other tendencies suggested by Zigler might also render these corrective prompts reinforcing. Thus, he suggests that individuals with a learning disability tend to differ from those without a learning disability in terms of their 'reinforcer
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hierarchy, such that the social interaction with a supportive adult provided by a corrective prompt may be more important than 'intangible' reinforcers such as mastering the task and being able to perform it without assistance. If corrective prompts were to possess strong reinforcing properties, then the learner's response may be guided by an attempt to ensure their occurrence - in which case acquisition would be impaired.

The effects of circumstantial variation on the motivational countereffects of errors need to be emphasized. Anecdotal evidence suggests that not all individuals with a learning disability react to errors with negative emotional behaviour or with passivity and unresponsiveness (Snell & Kneedler, 1978; Striefel & Owens, 1980). In the study by Carr and Durand (1985), one of their participants showed more disruptive behaviour on the easier task (i.e. when fewer errors were made). Indeed, such variation should be expected on theoretical grounds. The research on learned helplessness in humans indicates that its occurrence depends on the attributions made by the individual (Dweck & Rapucci, 1973; Dweck, 1975; Lawrence & Winschel, 1975; Chapin & Dyck, 1976; Thomas, 1979). Impairment of performance is more likely to occur amongst those who attribute their prolonged failure to a lack of ability or to external factors, and less likely to occur amongst those who attributed it to a lack of effort. Attributional cues provided by the teacher are also an important determinant of the effect, and persistence can be improved if the teacher provides appropriate attributions. Though it has been claimed that people with learning disabilities are generally more likely than others to attribute the outcome of their behaviour to external factors (Lawrence & Winschel, 1975), presumably some attributional variation nevertheless occurs. It should also be noted that the personality characteristics described by Zigler and his colleagues are not considered to be universal amongst those with learning disabilities. For example, they suggest that the tendencies are more prominent amongst those with a history of institutional residence (Balla & Zigler, 1979).

Finally, it is worth emphasizing that the theoretical and empirical evidence suggests that error-induced passivity and negative emotional behaviour depend on the occurrence of repeated errors on a task or a
prolonged history of failures. This is the case whether the theoretical support is offered in terms of learned helplessness or in the terms employed by Zigler and his colleagues. Single instances of extremely punishing stimuli (e.g. a severe electric shock) can suppress general responding or elicit negative emotional behaviour (Davey, 1981), but a failure to obtain reinforcement as a result of an error hardly falls into this category.

Performance Hypotheses

It has frequently been observed that errors made during training are not always a random selection from the available alternatives, but are often repetitions of errors made earlier. This has been observed in discrimination training (Hively, 1962; Sidman & Stoddard, 1967; Touchette, 1970; Schilmoeller et al., 1979) and on a variety of other tasks (Kay, 1951, 1954 and 1955; Belbin et al., 1964; Holding, 1970). On this basis, it has been suggested that errors may be learned during training and the learning of them interferes with the acquisition of the correct response.

Consistent with the behavioural principle that reinforcement is necessary for learning to occur, it is usually claimed that errors are learned because they are reinforced (Hively, 1962; Sidman & Stoddard, 1967; Touchette, 1968; Doran & Holland, 1979; Schilmoeller et al, 1979). In the context of choice discrimination learning, Hively (1962) offered an explanation of the reinforcement of errors in terms of the concept of 'adventitious reinforcement'. This derives from the work of Morse and Skinner (1957) which indicated that a stimulus can come to exercise spurious control over a response if that stimulus is adventitiously paired with the reinforcement of that response. Hively pointed out that, in a choice discrimination task, selection on the basis of some irrelevant feature may often coincidentally result in the selection of the correct stimulus. The consequent reinforcement for selecting the correct stimulus may then establish control by the irrelevant feature. For example, in a two-choice discrimination task, selection on the basis of an irrelevant feature such as position in the presentation will typically coincide with the selection of the correct stimulus on approximately 50% of trials. On the basis of this adventitious
This explanation is of limited application. Errors can be reinforced in this way only if the task component involves the selection of a stimulus from a randomly varied and limited set of stimuli. It has no application to the acquisition of the response component, since any error on such a component will not achieve the required outcome. It is also less plausible to apply the explanation to the acquisition of the stimulus component when there are a large number of stimuli in the presentation that may be selected, and consequently any error will only rarely coincide with the selection of the correct stimulus. Yet the evidence listed earlier provides examples of the repetition of errors in both types of learning. There is evidence of the repetition of incorrect response components (Kay, 1955; Holding, 1970), and of the incorrect selection of a stimulus on selection tasks which present a large number of stimuli (e.g. Kay, 1951 and 1954).

Are there other mechanisms whereby errors might be reinforced? We have, in fact, mentioned two possibilities in our earlier discussions. First, when considering motivational hypotheses, we noted the suggestion that corrective prompts may have pre-established reinforcing properties for some individuals (p.187). Second, in considering the increasing assistance procedure, we discussed the suggestion that, during training, corrective prompts may acquire the status of conditioned reinforcers in a chained response, either because the learner does not realise that reinforcement can be obtained without making the error, or because they are not sufficiently motivated to achieve this (p.157).

Again, however, both the accounts are somewhat limited in their application. This was noted in the earlier discussions (p.157, p.187). For example, only those with more severe learning disabilities are likely to fail to realise that making the error is not necessary to achieve reinforcement. Certainly neither account can offer a plausible explanation of why adults without learning disabilities repeat errors on tasks for which the explanation in terms of adventitious reinforcement has no application (e.g. Kay, 1951, 1954 and 1955; Belbin et al., 1964).

In Chapter 7 we shall reconsider the issue from the cognitive...
perspective and offer an account of how errors may be learnt, which has
general application. The account will not depend on the assumption that
the errors are being reinforced. It is interesting to note that the
failure to offer a plausible account of how the errors learned by adults
without learning disabilities on tasks other than limited choice
discrimination tasks are being reinforced, undermines the behavioural
assumption that reinforcement is necessary for learning (p.189).

Another argument put forward in support of the avoidance of errors is
that, put bluntly, errors are a waste of time (Holland, 1965; Skinner,
1968; Billingsley & Romer, 1983; Wolary & Cast, 1984). According to this
argument, nothing is learnt from making an error and they serve no other
useful purpose. Learning only occurs if the correct response is elicited
and reinforced. Thus the occurrence of errors simply wastes teaching
time. To be maximally efficient, teaching programmes should therefore
avoid errors. However, as we shall see in the next section, it is likely
that, at least in some circumstances, errors, and being given the
opportunity to commit errors, can serve some useful purpose.

6.4.3: The Potential Disadvantages of Measures to Avoid Errors

Measures to avoid errors will have potential disadvantages if the
commission of errors can, in fact, facilitate performance; or if there
are benefits to be gained by giving the learner opportunities to respond
with less helpful, or no, prompts (since measures to avoid errors must
necessarily restrict such opportunities). We give separate consideration
to these two possibilities.

Committing Errors

As in the discussion of the potential countereffects of errors, we
can distinguish between motivational and performance-related hypotheses.
In relation to the former, it is possible that the commission of errors
may improve, rather than impair, motivation. The basis for the
suggestion that they may impair motivation was the suggestion that errors
may function as aversive and punishing stimuli (p.186). In some
circumstances, the consequence of this may be disruptive emotional
behaviour or a lack of responsiveness which interferes with acquisition
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(p.185). However, it is plausible to suggest that, in other circumstances, the consequence may be that the learner increases their efforts to avoid errors in the future. Just as those subjected to shock may make efforts to avoid it, so those who make errors may increase their efforts to avoid them. The consequence of this may be an improvement in the probability or speed of acquisition. Circumstances presumably determine which effect, if either, occurs. For example, when the learner repeatedly fails on a task, or is sensitive to failure because of a long history of failure on other tasks, the negative effect may be more likely (p.188). A positive effect may occur when the errors are restricted in frequency and the individual is not sensitized by prior history.

Empirical data directly relevant to this suggestion is difficult to find. However, there is evidence that errors can have a general 'energizing' effect manifest in an increased frequency and speed of responding. For example, Terrace (1963a) found that those pigeons which had committed errors, subsequently responded more quickly to stimuli on discrete trials, and more frequently in the free-operant situation, than pigeons trained with an errorless strategy.

Chapin and Dyck (1976) suggest that the commission of errors may improve the maintenance of the acquired response and that errorless learning may result in decreased task persistence after training. They note that when errors are made during training, then the learner is on a partial reinforcement schedule; but when no errors are made, the schedule is one of continuous reinforcement. Relative to continuous reinforcement, partial reinforcement schedules generally lead to greater persistence when the response is no longer reinforced (i.e. extinguished) or is reinforced infrequently (Ferster & Skinner, 1957). Chapin and Dyck offered some empirical data in support of their hypothesis. Children who received a mixture of easy and difficult sentences to read (and were thereby provided with an experience of errors) showed greater persistence when subsequently required to read a further series of difficult sentences, than children who were given only easy sentences to read in the initial phase (and who therefore had no experience of errors). Chapin and Dyck also cited the data provided by Terrace (1966) according to which subjects who had received errorless training showed less persistence under extinction than those who had received trial-and-error...
A number of points can be made about this suggestion. First, we should note that there are limitations on its application. The hypothesized mechanism will only operate if there is a reduction in reinforcement after training. If the trained response continues to be frequently reinforced, then persistence in the face of reduced reinforcement will not be required and errors will have no advantage in this respect. Presumably, then, the putative advantage is less likely to accrue when the reinforcement is an intrinsic consequence of some mechanical process (e.g. switching on an electrical appliance rarely fails to be reinforced), but more likely when reinforcement depends on the behaviour of other people, which is naturally less reliable. A second point which merits comment is that, in the study by Chapin and Dyck (1976), the subsequent task was related (it, too, was a reading task) but not identical (it involved reading a different set of words). This suggests that an increased persistence due to errors may show some stimulus generalization (p.146) - that is, that errors may facilitate generalization of effort as well as its maintenance.

We consider next the potential performance-related benefits of committing an error. It has been suggested that through making an error the subject may learn not to make that error again - since it does not result in reinforcement and may be experienced as punishing (Kay 1951 and 1954; Skinner, 1968; Holding, 1970). There are various circumstances in which it would be an advantage for the subject to learn not to repeat an error. It will, of course, be an advantage in trial-and-error training if the subject is making a relatively systematic attempt to discover the correct response. Learning that a particular response is an error permits the subject to concentrate on other possibilities and not to waste time in repeating the error. However, our interest in the present context is whether, in devising a prompting strategy, the possibility of errors should be allowed. If we can prompt the learner to make the correct response, is there anything to be gained, in performance terms, by the learner committing an error? There are two situations in which such an advantage may accrue. First, in Chapter 3 (p.82) we noted that it is important that, in encoding information about the stimuli and responses, the learner should classify the items under concepts which are
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sufficiently discriminatory - otherwise the learner is likely to respond to a non-discriminated irrelevant stimulus in the task presentation, or is likely to make an incorrect response which is not discriminated from the correct response. If there is insufficient discrimination in the learner's classification, then it would be advantageous for the learner to make the error. For the error would indicate to the learner that the response needs to be refined. It will also indicate this to the teacher, who can then assist the learner to make the appropriate refinements. For example, suppose that some errorless prompting procedure were used to teach the subject to write the word 'dad' (e.g. the subject learned by tracing the word), but that the subject had not learned to discriminate in their output between 'd' and 'b'. In this case, the error would not emerge during training. By contrast, if the training procedure gave the subject the opportunity to perform during training with no assistance, the error would be likely to be detected. The second situation in which the commission of an error may have a performance-related benefit occurs when the prompt is exercising a spurious control over the response. Again, the commission of an error will reveal this to the learner and the teacher, and appropriate steps can be taken.

There is, in fact, some empirical evidence from the field of human skills research which supports the value of committing errors in the first of these situations. Macrae and Holding (1965), using a task in which the blindfolded subject had to move a marker exactly 4", compared guided training in which all the practice was on the 4" distance, with guided training in which the subjects were given practice at 2", 3", 4", 5" and 6". Although they had fewer practice trials on the 4" distance, those who had practised on the incorrect distances showed significantly more improvement on a pre- vs post-training test. Similar findings have been obtained in other studies (Newell & Shapiro, 1976; Williams & Rodney, 1978; Newell, 1981). On the basis of the argument in the previous paragraph, we might suggest that the errors improved the learners' ability to discriminate the correct response from errors (cf. Annett, 1969). Indeed, we might suggest that this process of acquiring greater response accuracy by means of discriminating the correct from incorrect responses is one of the mechanisms whereby practice can ensure the development of the necessary degree of precision required for execution of the response (p.88). In this case, errors may be important
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in facilitating the effects of practice.

Skinner (1968), though admitting that through making an error the learner may learn not to make that error again, nevertheless maintains that committing the error is not the best way of learning not to make it again. Because of the risks attached to the commission of errors, it would, Skinner argues, be preferable to teach the learner to avoid the error by making its avoidance an explicit teaching target in a programme which does not require the learner to commit the error. The research on human skills does, in fact, provide some preliminary empirical support for Skinner's position. Von Wright (1957) compared three ways of teaching the way through a maze - trial-and-error training (errors made), showing the subject only the correct path (no errors and no information about errors), and showing the subject all the paths but indicating which were dead-ends (no errors, but information about errors). The third method proved the most effective. Similar findings were reported by Carr (1921).

However, some objections may be raised against Skinner's argument. First, we must not assume that every error committed is likely to interfere with acquisition. This is clear from the discussions in the previous section, and will become clearer when we reconsider the issue from the cognitive perspective. If we can specify the circumstances in which interference is unlikely to occur, then Skinner's argument will lose its force in respect of those circumstances. Second, making the avoidance of certain errors an explicit part of the programme increases the time required to complete the programme. This would be a source of decreased efficiency if, as is likely, time were spent teaching about errors that would not, in any case, have occurred. Furthermore, on some tasks there may be a relatively large number of potential errors. If too many errors are included in the teaching programme, the learner, for reasons which will become apparent in the next chapter, may become confused and this may increase the risk of errors being learnt. In such circumstances, it may be more efficient and effective to permit errors to be made and, if one is made, to then make its avoidance an explicit part of the teaching programme.

There is another potential performance-related advantage in
committing an error. The nature of some tasks is such that even when the learner can perform it without assistance, errors are still likely to occur. This is particularly so with tasks which require a great deal of motor precision. Furthermore, the nature of some of these errors is such that, in order to complete the task, the learner will need to implement (and therefore will need to learn) some remedial strategy for correcting the error. For example, it is not unusual for even skilled knitters to drop the occasional stitch, and it is accordingly necessary for them to have learnt the appropriate remedial strategy. Following the line of Skinner's suggestion, we might wish to make such remedial strategies an explicit part of the teaching programme without permitting the learner ever to make the mistake during training. Again, however, a disadvantage of this is that it may decrease the efficiency of the programme by including teaching about errors that would not, in any case, have occurred; and, in the case that there are many potential errors, may have the effect of teaching the learner to commit an error. Moreover, the commission of the error is presumably an important natural discriminative stimulus for implementation of the remedial strategy, and responses are better taught in their natural context (Stokes & Baer, 1977). Again, then, it may be preferable to teach the strategy after, rather than before, the error has been committed.

Providing the Opportunity to Respond with Reduced or No Assistance

Even if committing an error does not in itself have any facilitatory effect, giving the learner the opportunity to perform with reduced or no assistance (and thereby running the risk of errors being committed) may nevertheless be of some benefit. For giving the learner such an opportunity reduces the risk of overprompting (p.156). The disadvantages of overprompting were considered earlier in the chapter (p.156). It may impair efficiency because more trials than necessary are given, and, assuming the effectiveness of fading, because the prompts give too much assistance. It may also have motivational countereffects.

There is another potential problem with providing too much assistance, though it does not relate directly to the acquisition of the specific task. Such teaching does not give the individual the experience of using their own internal abilities and resources in an attempt to
determine the correct response, and this experience may make an important contribution to the acquisition of this invaluable covert behaviour (Cronbach, 1962; Fitzgibbon, 1965). Put another way, under such teaching the individual may not acquire the general intellectual skills required in problem-solving. They may also fail to learn as readily that mental effort can be effective in achieving desired outcomes. As we noted earlier (p.188), the attribution of outcome to effort may be an important determinant of task motivation. More fundamentally, it may also play an important role in the development of the concept of oneself as an agent operating upon the external world (Kopp, 1982; Clements, 1987).

Skinner (1968) considers the objection that errorless learning will not foster the acquisition of problem-solving skills. His reply is that problem-solving skills should be taught explicitly in separate teaching programmes, rather than reliance placed on their acquisition by means of the difficulties experienced in teaching other skills. This is less haphazard and it avoids the risk of errors being committed during the learning of these other skills. It is, of course, a valid point to suggest that problem-solving skills should be taught explicitly (though it is difficult to envisage how they could be taught without giving the learner the opportunity to respond under conditions of reduced or no assistance (and thereby run the risk of errors)). However, teaching problem-solving skills explicitly to those with more severe learning disabilities may be difficult because of the abstract and general nature of the topic. They may need to learn through concrete and specific experiences of determining the answer on the basis of their own resources. Moreover, Skinner's objection rests on the assumption that the commission of errors will necessarily impair learning. We have argued that this is not the case. If we can specify the circumstances in which it will not be the case, then his objection would have less application in such circumstances.

6.4.4: Dealing with Errors

In this section we consider the question of how the teaching programme should deal with the occurrence of errors. The discussion of this issue is not entirely within the scope of this thesis, in that it requires consideration of aspects of the teaching programme other than
prompts (e.g. reinforcement). Accordingly the treatment of the issue will be somewhat restricted. It should be noted that some of the discussion also applies to the issue of how the teaching programme should respond to a failure to respond.

It is common practice to respond to an error by giving a more controlling prompt, and then to reinforce fully any correct response which follows (Wolery & Gast, 1984; Doyle et al., 1988). Skinner (1968) argues for this practice on the grounds that if we do not provide a corrective prompt in response to an error, then we miss the opportunity on that trial to elicit and reinforce the correct response. However, from our previous discussion (p.190), it will be apparent that this practice may, in some circumstances, be countereffective. Corrective prompts may have pre-established reinforcing properties for some individuals (p.187); or they may acquire the function of conditioned reinforcers during training, either because the learner does not realise that the reinforcement can be obtained without making the error, or because they are not sufficiently motivated to achieve this (p.157). Some researchers have suggested that unprompted correct responses, or those elicited with a less controlling response, should be preferentially reinforced (Striefel & Owens, 1980; Csapo, 1981; Striefel et al., 1974; Touchette & Howard, 1984; Doyle et al., 1988). Thus, correct responses given only after a prompt, or after a more controlling prompt, would be given less reinforcement. Indeed, in the context of prompt delay, Touchette and Howard (1984) compared different schedules of reinforcement and observed that the target was more rapidly acquired when the schedule favoured unprompted responses, than when it favoured the prompted response or favoured neither. However, care would need to be exercised in this. It may be important always to provide some reinforcement for the correct response that is subsequent to an error or a more controlling prompt. The learner may become confused about the nature of the correct response if it is sometimes reinforced but sometimes not. Moreover, in terms of Skinner's assumptions (that the reinforcement of a response is necessary for it to be learnt), there would be no point in eliciting the correct response subsequent to an error if it were not then reinforced in some way. Furthermore, the practice of differential reinforcement may be of less value when, as is ideally the case, the main reinforcer is a
natural consequence of the correct response which cannot be varied (though it may be possible to vary the supplementary reinforcers such as praise).

Another option is to consequate errors with a mild punishment. Doyle et al. (1988) report some studies in which errors were followed by a brief time-out in the form of the removal of the task materials. Close et al. (1978) used overcorrection (i.e. repeated practice of the correct response) and found it to be more efficient than a single correction in terms of trials to criterion. However, it is unclear from the study whether the increased efficiency was due to the punishing aspects of overcorrection, or to the fact that it provided more practice of the correct response. Indeed, the fact that the overcorrection procedure in effect involved several trials within each trial, calls into question their claim that it was more efficient. Again, the practice of punishing errors requires a cautious approach. It may exacerbate the adverse motivational effects of an error for vulnerable individuals by increasing its punitive strength.

There are other options to be considered. The trial could be ended when a mistake is made. This might prove problematic for those who are frustrated by any delays in reinforcement (p.186). Another option would be to use the occurrence of the error as an opportunity to teach the learner not to repeat the mistake - for example, by explicitly teaching a discrimination between the error and the correct response (p.193, p.195). Finally, as noted earlier (p.188), the attributional cues provided by the teacher may determine the motivational effects of errors. An encouraging response by the teacher to an error, both in terms of attribution and more generally, may reduce the probability of a harmful effect.

6.4.5: Conclusion

The avoidance of errors is often given considerable weight in the devising of prompting strategies (Billingsley & Romer, 1983; McDonnell & Laughlin, 1989). However, it is clear from the foregoing discussion that the issue is more complex. The commission of errors, and the provision of an opportunity to perform under conditions of limited assistance, may also have advantages. Moreover, it is incorrect to assume that an error
will impair the processes of acquisition in all circumstances, and there are procedures that may reduce the probability of a detrimental effect. In devising a prompting strategy, then, one needs to take into account the potential advantages of permitting errors, as well as their disadvantages; one must assess the probability of each of these in the particular circumstances in hand; and one needs to give consideration to their consequation.

6.5: PRE- vs POST-RESPONSE PROMPTING

Pre-response prompting refers to the practice of giving the prompt before the learner has the chance to respond independently. Post-response prompting refers to the practice of giving the information about the correct response only after the learner has made an error or appears unlikely to make any response. Typically, an overt response to the corrective prompt is then required. In the context of the debate about their relative merits, post-response prompting is sometimes referred to as 'confirmation', and the term 'prompting' is reserved for pre-response prompting (Aiken & Lau, 1967).

In terms of the principles discussed earlier, we can see advantages and disadvantages for both practices. Confirmation has the potential disadvantage of permitting errors, and thereby their countereffects, to occur (Section 6.4.2). However, the commission of errors, and the provision of the opportunity to respond under conditions of limited assistance, also have potential advantages (Section 6.4.3). 'Prompting' has the converse advantages and disadvantages. Accordingly, just as with the issue of which form of fading is preferable (p.159) or whether fading or delay is to be preferred (p.178), we might expect neither 'prompting' nor confirmation to show any universal or overall superiority. Depending on the circumstances, sometimes one will be more effective/efficient, sometimes the other. Relevant circumstantial determinants are likely to include the learner's history (p.174, p.187), the ability of the learner (p.165, p.174), their motivational characteristics (p.166, p.174, p.187), the nature of the task (p.158, p.174, p.190), and the stage of task acquisition which the learner has reached (p.159). The latter may be expected to be particularly important — confirmation in the earlier stages of acquiring a difficult task may be expected to result in a large
number of errors, and 'prompting' in the later stages may be more likely to result in overprompting.

Some studies have investigated the relative effectiveness/efficiency of 'prompting' and 'confirmation'. There is a substantial body of research which has examined this issue using subjects without learning disabilities (e.g. Cook & Spitzer, 1960; Sidowski et al., 1961; Cook, 1963). Aiken and Lau (1967) provided an extensive review of this work. The issue has been investigated using a variety of tasks such as paired associate learning, signal detection, perceptual identification and discrimination training. In a substantial number of the studies 'prompting' was more efficient/effective than confirmation. Given our expectation that the application of confirmation in the early stages of training may often result in a large number of errors, and the fact that in all these studies it was applied from the start of training, this is not too surprising. However, in some studies, confirmation was superior. This was particularly so in studies which used discrimination training, and those which compared the effects of the two procedures during the later stages of learning. 'Prompting' was also less likely to show a superiority when the learners were more able.

The issue has also been investigated in studies which used people with learning disabilities as the subjects (Greene, 1966). Thus Stolurow and Lippert (1964) found 'prompting' to be superior in training a sight vocabulary in terms of trials to criterion, but that, when the words were overlearned, the confirmation procedure led to better retention (i.e. better maintenance). Hawker and his colleagues (Hawker et al., 1964; Hawker, 1968; Hawker & Keilman, 1969) found no difference between the two procedures in the acquisition of various perceptual identification tasks (including reading), but the confirmation procedure again led to better maintenance and to faster relearning. These findings of superior maintenance under a procedure which did not produce superior acquisition, are similar to the finding of Wolery et al. (1990) that, although delay led to more efficient acquisition, fading led to superior maintenance (p.182). Zane et al. (1981) compared 'prompting' and confirmation in teaching an assembly task. There was a slight superiority for 'prompting' in terms of teaching time to criterion. However, interpretation of the results is difficult in that confirmation involved
the presentation of the prompt even after the participant had made the
correct response. This may have confused the learners, as well as adding
unnecessary teaching time. Moreover, under the 'prompting' condition,
there were fewer occasions when the criterion was reached (i.e. prompting
was less effective. Day (1987), in teaching an assortment of
discrimination, sorting and assembly tasks to individuals with profound
learning disabilities, observed that 'prompting' led to a higher
percentage of correct responses on probe trials.

6.6: PARTIAL TASK TRAINING

We use the term 'partial task training' to refer to the procedure of
eliminating the requirement on the learner to perform certain components
of the task during the initial training, and then (gradually or abruptly)
reintroducing the eliminated components. Prompts represent one way in
which task components can be eliminated¹. Both stimulus prompts and full
physical guidance can be used for this purpose. The eliminated
components may be those which have to be performed simultaneously with
the remaining component (the 'targeted' component), or, in the case of
chained responses, those which precede or succeed the targeted component
in the chain. Some examples can serve to illustrate these various uses:
Stabilizers on the back wheel of a bicycle are stimulus prompts which
eliminate the need to balance the bicycle at the same time as pedalling
and steering it; and full physical guidance may be applied in teaching
cutlery use such that the learner is initially taken through the complete
sequence of steps with the exception of the last one (putting food in the
mouth) which the learner is required to complete for themselves.

In this section we consider the advantages and disadvantages that
partial task training may have relative to no-prompt training, and to
'whole task training' (i.e. training in which the learner has to complete
all the task steps). We also consider the relative merits of two
variants of partial task training ('backward' and 'forward' chaining).

¹ Other methods include teaching a component in isolation from the rest
of the task (Engelman & Carnine, 1982); or teaching it in the context of
a different, less complicated task (Engelman & Carnine, 1982); or the
completion of the steps by the teacher without the learner's involvement.
Partial Task Training vs No-prompt Training

In the case of prompts which eliminate simultaneous components, their effect will be to reduce or eliminate the simultaneous attentional demands imposed by other components in executing the targeted response. We have already considered how this outcome of prompting can facilitate acquisition. By reducing the simultaneous attentional demands, we may increase the probability of the learner executing the targeted response (p.101). In the case that the learner needs to understand the task requirements (i.e. to encode the relevant information), the execution of the targeted response can provide the learner with at least some of the required information (p.99). In the case that the learner understands the task but has difficulty in executing the response, the execution of the response can provide the learner with the practice needed to overcome this difficulty (p.102).^1

What of prompts which eliminate sequential components? Sequential components, too, may make demands on the attentional resources available for execution of the targeted response if these components need to be executed very soon before, or very soon after, the targeted response (p.88). Shifts of attention take time (Glass & Holyoak, 1986). An attentionally-demanding component which immediately precedes the targeted component may thereby interfere with the latter's execution; and preparation for the shift of attention to a subsequent component may interfere with the execution of the targeted component. Furthermore, sequential components may also deplete the attentional resources available for the targeted component if the task is very demanding and the learner finds it difficult to sustain an adequate level of concentration throughout.

Engelman and Carnine (1982) argued for the elimination of sequential components on the grounds that an effective way to teach a motor response

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^1 The difference between partial task training and the application of prompts discussed earlier (p.98) is that, in the latter, the attentional demands made by simultaneous components are reduced by decreasing the precision or power required for their execution, rather than by eliminating the component altogether.
whose topography is relatively new to the learner, is to induce the
learner to emit the response a large number of times at brief intervals.
However, if the whole of a lengthy chained response is performed on each
training trial, the intervals between the repetition of a novel motor
component may be too long for this to occur. Eliminating the sequential
components permits the repetition of the targeted component at more
frequent intervals. However, Engelman and Carmin do not explain why the
rapid repetition of the response would facilitate its acquisition. One
possibility is that such repetition would facilitate the effects of
practice in the acquisition of a response whose general nature is
understood, but whose controlled execution is difficult (p.102). In
discussing errors, we suggested that practising correct and incorrect
variants of the response may help the learner to discriminate the correct
response more accurately (p.194). The learner may be able to
discriminate them more effectively if they are emitted with less time
between them. A second possibility, which we shall consider more fully
in the next chapter, is that rapid repetition facilitates recall of the
required information.

More generally, we might suggest that partial task training, insofar
as it reduces the amount of newly learnt information that needs to be
recalled on each trial, facilitates the recall of that information by
reducing the possibility that different items of newly learnt information
interfere with each other's recall. This account, too, will be more
fully discussed in Chapter 7.

Controlled empirical studies of the effectiveness of partial task
training (i.e. comparisons of the relative effects of partial task
training and no-prompt training) are difficult to find. However, the
response chains taught in some of the animal studies using partial task
training were of such length and novelty that it is most unlikely that
they would ever have been acquired under no-prompt training (e.g.
Schlosberg & Solomon, 1943; Skinner, 1972 - see below).

Partial vs Whole Task Prompting

These advantages that we have suggested for partial task training
over no-prompt training are also enjoyed by the former in relation to
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whole task training. Since the partial task procedure reduces or eliminates the attentional demands made by other task components (p.202), it will have an advantage over whole task training when the attentional demands of the task are so high that the learner is unable to emit the whole set of responses without a reduction in those demands. Even if a whole task strategy were used in which prompts were used to reduce those demands without eliminating the components (see footnote p.203), the partial task procedure may still have an advantage in some circumstances because, by eliminating the components altogether, it can effect a greater reduction in their demands. Moreover, partial task training may facilitate the acquisition of novel responses by enabling their rapid repetition (p.204), and this is not a mechanism which the whole task approach can allow to operate when the task is a lengthy chained response. The other potential advantage of partial task training accrues from the fact that it can reduce the amount of newly learnt information that has to be recalled on each trial. Again, this is not achieved by whole task training.

However, partial task training may also possess some disadvantages relative to the whole task procedure (McDonnell & Laughlin, 1989). It does not give the learner the opportunity to perform the non-targeted steps with reduced or no assistance (until, that is, they become targeted steps). Consequently, relative to no-prompt training, there is an increased risk of overprompting, the disadvantages of which we have considered earlier (p.156). We thus come to a familiar type of conclusion (cf. p.178): It is likely that the partial task procedure will be superior in some circumstances, but that the whole task procedure will be superior in others.

A number of studies have compared backward chaining with whole task prompting. Some of these studies observed the whole task strategy to be more efficient (Zane et al., 1981; Spooner et al., 1983; Spooner & Spooner, 1984; Kayser et al., 1986), though one study (McDonnell & Laughlin, 1989) found no difference.

Backward vs Forward Chaining

A particular type of sequential elimination is known as 'backward
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chaining' (Yule & Carr, 1980). In this strategy, the requirement on the learner to complete the earlier steps of the chained response is removed and the learner has to perform only the last step in the chain. The other steps are then gradually introduced in a sequence which moves backwards from the last step. By contrast, in 'forward chaining' the learner initially learns the first step in the chain before progressing to the second step, and so on.

Backward chaining has been used to teach lengthy and novel chains of behaviour in animals (e.g. Schlosberg & Solomon, 1943; Skinner, 1972). For example, part of the task taught to rats by Schlosberg and Solomon required them to jump through a swing door into a compartment from a platform some 16" from the door. Initially, the jumping stand was placed next to the compartment and the swing door held open, so that the rats could simply walk into the compartment to obtain the food placed there as a reinforcer. Then, the jumping stand was moved progressively further away from the compartment, though the door remained open. In the next stage, the door was progressively closed.

Backward chaining may have a specific advantage over forward chaining in that it can sometimes provide the learner with knowledge of the immediate goal of each step in the chain and thereby provide some guidance in the learner's attempts to emit the required response. When backward chaining is applied, the last step in the chain needs to be one which is already within the learner's repertoire, or which can readily be prompted. Once it has been emitted, the learner is provided with information about the overall goal. When the penultimate step is introduced, then the learner may realise that the overall goal can be achieved by getting into a situation in which the last step can be made. In this case, the learner is given information about the goal of the penultimate step (i.e. to get into the situation in which the last step can be made). Armed with this knowledge, the learner can then emit relatively systematic attempts to get into that situation (p.99). By the same process, knowledge of the goals of the earlier steps may be imparted. For example, in the study of Schlosberg and Solomon (1943) that was described earlier, once the rat had walked into the compartment during the initial stage of training, it was given knowledge that food had been placed in the compartment. Getting into the compartment in
order to get to the food may thereby have become the goal the achievement of which guided subsequent responses when the task was further altered. By contrast, under forward chaining, emission of the initial (or subsequent steps) will provide the learner with no information about the goal of the next step in the chain. Attempts to emit the response for that step will therefore not be guided by a knowledge of the goal and this may make it less likely that the response will be made (cf. p.85). For example, in the study by Schlosberg and Solomon (1943), it seems unlikely, in the event that a forward chaining procedure had been used, that many of the rats would have jumped across a 16" gap through a closed door.

The probability of the targeted response occurring under a forward chaining procedure could, of course, be increased by prompting it. If prompts can be used effectively to elicit the targeted response (to be effective it must elicit both the overt and the necessary attentional responses), then backward chaining may lose its advantage. However, in some circumstances it will be difficult to prompt the targeted responses effectively. Again the study by Schlosberg and Solomon (1943) can illustrate this. To prompt the rat to jump across the 16" gap, it would presumably have been necessary either to push the rat off the jumping stand (or otherwise cause it to leave) in the hope that it would jump through the door, or to carry the rat across the gap into the compartment (i.e. full physical guidance). In the former case, it seems likely that such a prompt would often be ineffective. In the latter case, the procedure then becomes an instance of backward chaining in which physical prompts, rather than stimulus prompts, are used to remove the necessity of completing the initial steps.

Finally, it should be noted that this advantage to backward chaining will only occur in the case that the task, and the analysis of it into steps, are such that, when the requirement to execute the previous step is introduced, it will be reasonably clear to the learner how to get into the situation in which the next step can be performed. Though this was the case in the example described from by the study by Schlosberg and Solomon (1943), there are presumably some chained tasks in which, to an inexperienced learner, there may be no clear connection of this kind between the steps.
CHAPTER 7: PROCEDURES - A THEORETICAL RECONSIDERATION

In this chapter we discuss the implications of the cognitive approach for the procedural aspects of prompting strategies. The basic characteristic of this approach is that learned responses are considered in terms of the encoding, storage and subsequent retrieval and application of information about the response (p. 80). In devising a prompting strategy, we should be concerned, first to ensure accurate encoding, and then to ensure unassisted recall (p. 92). Some procedural issues relate to the encoding stage of this process. These were considered in the previous chapter. However, most relate to the retrieval stage. Accordingly, the primary concern in this chapter is what procedures may facilitate the unassisted recall of the relevant information.

The chapter first describes a basic cognitive account of the processes involved in recall (7.1). On the basis of this account and the relevant empirical research, we then consider what manipulable factors are likely to determine the probability of unassisted recall (7.2). Against this background, we re-consider the rationale for the established prompting procedures (7.3), and provide rationales for some relatively novel procedures (7.4).

7.1: A BASIC COGNITIVE ACCOUNT

First, then, we describe a basic account of the processes involved in the recall of a required item of information. The account is based primarily on the processing approach to memory and connectionist models of cognitive functioning (Collins & Quillian, 1972; Tulving, 1972; Anderson & Bower, 1973; Tulving & Thomson, 1973; Collins & Loftus, 1975; Collins et al., 1975; Neely, 1977; Lindsay & Norman, 1977; Tulving, 1979; Jacoby & Craik, 1979; Craik, 1979; Anderson & Reder, 1979; Wingfield & Byrnes, 1981; Glass & Holyoak, 1986).

A memory record of a required item of information contains all the
information that was encoded at the time of input. It thus contains not only the required item of information, but also what may be termed 'associated information'. This is information which concerns the external context in which the required information is presented, or information which is internally-generated because of some prior association with the required information. For example, in respect of someone trying to recall a particular word on a list, the relevant record will typically contain the required information (that 'butter' was on the list) and associated information, which may relate to external input (e.g. 'butter' appeared after 'bread' on the list) or be internally generated (e.g. 'I feel hungry'.)

A memory record is constituted by a specific pattern of connections amongst the representations in memory of the objects, properties, events or states which the stored information (both required and associated) concerns. The effect of these connections is such that, when some part of the record is subsequently activated (by a subsequent encoding of the information contained in that part), its activation will tend to be transmitted to the remaining parts of the record. Furthermore, the greater the number of parts activated by the subsequent encoding, the greater will be the level of activation transmitted to the remaining parts.

When the same item of required information is encoded on several occasions, there will be several particular records of that information. However, the required information will be common to all of the records. We can thus postulate the existence of a 'common' record (or 'semantic' record - Tulving, 1972) which contains required information which has been encoded on several occasions. Each time the required information is encoded, the specific pattern of connections which encodes the information may again be established. The effect of this is that the connections in a common record are generally stronger than those in a particular record, and they tend to become stronger with each encoding. Consequently, when some part of the common record is activated, it will tend to transmit stronger levels of activation to the other parts of that common record. The several particular records of the required information are likely to differ in respect of the associated information that they contain. However, there is likely also to be some overlap, the
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effect of which will be to increase the levels of activation that subsequent encoding of these overlapping items of associated information transmits to those parts of the records containing the required information. Subsequent encodings of an item of information may occur because the item has been re-presented or because it has been recalled (i.e. recall serves to re-encode the information).

When the recall of an item of information is required, the need will be indicated to the individual by the presentation of some part of the required information or some part of the associated information. The encoding of this information will activate the appropriate parts of the memory records containing that information. This will, in turn, activate the remaining parts of those records, including that part which contains the required information. Unless the recall happens readily, the individual may also engage in further processing in an attempt to activate the remaining parts of the required information. This may take the form of further processing of the external context, or the internal generation of further associations.

The successful recall of the required information depends on the level of activation transmitted to the remaining part of the record containing the required information: The more activation it receives, the more likely recall is to occur. As the account has already implied, the level of activation depends on the number of parts of the record that are activated at the time of the attempted recall (in other words, the degree of overlap between the information encoded in the record and the information encoded at the time of the attempted recall), and the number of previous encodings of that information.

However, strong activation of the remaining part is not sufficient for recall to occur. The information encoded at the time of attempted recall may overlap, not only with the record containing the required information, but also with records containing other information. These records, too, will be activated. If the activation transmitted to these other records is as great as, or greater than, the activation transmitted to the appropriate record, then this other information is likely to be recalled. A connectionist system operates on the basis of selecting for
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Further processing that information which is most strongly activated. The recall of erroneous information will, at best, delay the recall of the required information. At worst, it may prevent it. This may happen if the recalled information is not recognized as erroneous, so that the individual makes no attempt to recall the correct information. It may also happen because the recall of one item of information may, in certain circumstances, actively inhibit the recall of other associated items (Nealy, 1977). From the principles described earlier, it will be apparent that the recall of an erroneous record is more likely to occur, the greater the overlap between the information contained in the erroneous record and the information encoded at the time of attempted recall, and the more often the erroneous record has been retrieved. This, in turn, implies that errors are likely to take the form of items of information which are in some way associated with the relevant information.

The activation of a record decays gradually over a period of time. If it receives further activation before the previous activation has completely decayed, then the level of activation of the record will be the sum of the two sources. The implication of this is that recall is more likely if it is required during the period of decay than if it is required after the previous activation has decayed completely.

Finally, some of these processes will be dependant on the amount of attention allocated to them (p.87). For example, the process whereby the learner encodes more of the external context, or generates more associated information in attempting to recall the required information, presumably falls into this category. It may also be the case that the probability of an encoding being stored is dependant on attention.

7.2: MANIPULABLE DETERMINANTS OF RECALL

On the basis of the preceding account and the empirical evidence, this section considers, in general terms, what factors can be manipulated in order to facilitate unassisted recall. We discuss these factors under two headings - the quality of the initial encoding, and the elicitation of recall on the teaching trials.
The Quality of the Initial Encoding

If the level of activation (and thereby the probability of recall) is dependent on the number of parts of the record that are activated at the time of attempted recall, and if the record includes associated as well as the required information, then recall may be facilitated by measures designed to increase the amount of associated information that is initially encoded. For, in the event that the associated information is re-presented and encoded by the learner at the time of attempted recall, then the greater the amount of this information that was initially encoded, the greater will be the number of parts of the record that are activated at the time of attempted recall (i.e. the greater will be the overlap between the information encoded initially and the information encoded at the time of attempted recall) - and consequently, the greater will be the probability of recall.

The process of initially encoding associated information has been termed 'elaboration' (Anderson & Reder, 1979; Craik, 1979). It may take various forms. For example, the learner may be encouraged to encode more of the external context in which the required information is presented - that is, information concerning other aspects of the task stimuli or concerning the circumstances in which the task is performed. A somewhat unusual demonstration of the effectiveness of elaborating with reference to the circumstances of learning was provided by Godden and Baddeley (1975). Divers who had learnt a list of words on shore or underwater subsequently recalled the words more accurately in the environment in which they were originally learnt than in the alternative environment. Alternatively, the learner may be provided with, or induced to provide for themselves (i.e. to generate internally - p.209), previously associated information. For example, the recall of paired associates can be improved by instructing the learner to link the two words by means of an image or sentence which combines them (e.g. Queen-Pencil may be recalled more readily if the learner forms an image of a queen writing with a pencil) (Reese, 1965). An important form of elaboration involves relating the required information to one's existing knowledge and beliefs. For example, Anderson and Reder (1979) list some of the elaborative analyses typically conducted in attending to a passage of prose. They may include inferring the causal relations between different
events, imputing motives for the behaviour of the characters, determining the logical connections between the different events or ideas, generating predictions about what will happen, generating imagery etc. Such analyses are, of course, essential to the comprehension of the passage. The processes of comprehension may therefore be considered to be facilitative of recall (Glass & Holyoak, 1976).

Another particularly important type of elaboration involves the imposition of a structure on the information that is to be recalled (Wingfield & Byrnes, 1981). In general terms, the method requires the learner to link each part of the required information to a particular part of the structure. Because they are linked in this way, the recall of a particular part of the structure should serve to activate the corresponding part of the required information (p.209). It should be particularly effective in this respect if there is some pre-existing association between them (p.210). For various reasons which we shall consider in a moment, the several parts of the structure may be more readily recalled than the parts of the required information, or the parts of the unstructured associated information. Consequently, their recall (and accompanying activation) may provide a more reliable means of ensuring the activation and subsequent recall of the required information than reliance on the recall of parts of the required or unstructured associated information.

One of the reasons why the structure may be more readily recalled than the required information is that it provides an abstract summary of that information. Being an abstraction, such a structure will contain less information than the required information itself. Presumably, other things being equal, an item containing less information is easier to learn than one containing more information (e.g. it is easier to recall a sentence than a paragraph). An example of such a structure and its application is provided by the use of acronyms to aid memory. The first letter(s) of each word of the required information is abstracted. These letters are then used to form a word. When recall of the required information is required, the learner first recalls the acronym. Each part of the acronym may then be used to assist in the recall of the corresponding item of required information. For example the acronym, 'H.Helibonof' (a legendary chemist), can be used to facilitate recall.
of the first nine elements in the periodic table. Evidence for the effectiveness of abstract structures is provided by research on the effects of category cueing on the recall of word lists (Wingfield & Byrnes, 1981). For example, Pollio and Gerow (1968) presented subjects with a 25-item list consisting of five categories of five items each. Subjects who were told beforehand what the categories were, outperformed those who were given no such information. Presumably, the performance of the former was enhanced by their recall and use of the category labels.

A particular type of these abstract structures are known as 'schemata' (Bartlett, 1932; Bobrow & Norman, 1975; Bransford, 1979; Wingfield & Byrnes, 1981; Glass & Holyoak, 1986). These are structures which contain a summary of the general features of a chained response. Most of the research has been done on the recall of connected prose. Individuals skilled in the recall of such material typically extract the gist of the passage - that is, the main ideas and the connections between them - and then use the recall of this gist to help themselves recall the specific details. The implementation of chained perceptuo-motor skills may involve similar schemata or 'scripts' (Schank & Abelson, 1976). These scripts are hypothesized to be organized into 'scenes', each scene dealing with a related block of steps. One of the ways in which the scripts may assist implementation of the skills is that recall of the scene titles can facilitate the recall of the specific steps.

The structures may be easier to recall than the required information itself for reasons other than their brevity. First, they may be easier to recall because they have already been learnt on previous occasions. Several well-known mnemonic techniques use structures of this nature. For example, the 'Method of Loci' (Wingfield & Byrnes, 1981) requires the learner to visualize the items to be remembered being placed at strategic points on a well-known journey. When recall of the items is required, the learner recalls the journey step-by-step and thereby facilitates the recall of the items. Presumably, the learner has no difficulty in recalling the steps of the journey because it is so well-known. Second, they may be easier to recall because the parts of the structure have an intrinsic connection with each other (an intrinsic structure) which the parts of the relevant information do not. These intrinsic connections may serve to aid recall of the different parts. For example, a common
mnemonic for remembering the colours and their order in the visible spectrum is the sentence, "Richard of York Gained Battles in Vain", which corresponds to Red, Orange, Yellow etc. The intrinsic structure of this device is provided by its meaning and the rules of grammar. The restrictions imposed by this structure make it likely that all its parts will be recalled (any omissions change the meaning or make it nonsensical), and that they will be recalled in the right order (any changes in the order render it nonsensical). As well as meaning and grammar, rhythm, rhyme and even musical intonation may be used to provide the intrinsic structure for a mnemonic device. For example, the letters of the alphabet are commonly learnt by setting them to a tune, and the number of days in each month by setting the information within a verse. Because they can facilitate recall of the precise order of a series of items, such devices may be particularly useful for tasks in which it is important to recall the information in a set sequence.

Structures can also be used, in conjunction with existing knowledge and skills, to assist the learner to *generate* rather than to recall specific responses. For example, in learning about prose passages, experienced students will typically extract and store the gist, rather than attempting to learn the passage verbatim (Glass & Holyoak, 1986). At the time of recall, they retrieve the gist and use it, in conjunction with their existing knowledge, to generate specific responses which are semantically, though not necessarily formally, identical to the original specific responses (i.e. a paraphrase). On the assumption that the gist will be easier to learn and recall, this technique will improve efficiency by removing the need to spend time in learning the precise form of the specific responses.

Skinner (1968) also noted the use of this technique by skilled students in learning about a passage. Such students, he observed, extract 'thematic stimuli' from the passage, and later use these stimuli, which already elicit established intra-verbal responses, to emit a paraphrase of the text. In this connection, Skinner urged that programmes of instruction should aim to build up thematic relationships of this kind, and that greater use should be made of thematic, as opposed to formal, prompts. However, it is not entirely clear what Skinner meant by the distinction between thematic and formal prompts, nor is it clear
why he considered that greater use should be made of thematic prompts. The theoretical framework used in the present discussion offers a means of clarifying these points. The programmes of instruction written by Skinner and his colleagues provide many examples of the technique being discussed. For example, in teaching the response that 9 multiplied by 7 is equal to 63, Skinner suggests a prompt which indicates that the product of any multiplication by 9 is equal to the product of that number multiplied by 10, less that number (Skinner, 1968). By learning this general rule, the learner is able, in conjunction with an existing (or more readily determined) response (i.e. products of 10), to generate the specific responses for particular multiplications by 9 without learning those specific responses. The learning of rules, rather than specific responses, is a strategy of considerable practical importance.

Measures to increase elaboration and to encourage the use of structuring devices have also been found to improve the recall of individuals with learning disabilities. For example, providing category labels for the learning of word lists, and grouping the words in such lists according to category, have both proved effective (Glidden, 1979). In paired associate learning, recall has been improved by inducing the learner to form an interactive image of the pair or to place them together in a meaningful sentence (Taylor & Tumure, 1979). Similar measures have also been successful in improving recall for propositional knowledge of a more ecologically useful nature (Taylor & Tumure, 1979). For example, Bender and Levin (1978) observed that the provision of a picture depicting the content of a prose paragraph, assisted in the comprehension and recall of that paragraph; and Taylor et al. (1977) found that the recall of word meanings was facilitated by explaining the meaning in the context of a story rather than presenting it in a straightforward way. It is worth noting that most, though not all, these studies have involved individuals with less severe learning disabilities, and that, relative to those without learning disabilities, the teacher typically needs to offer more assistance and direction in promoting the use of elaboration and structuring devices (Taylor & Tumure, 1979; Glidden, 1979).

In describing the basic model of recall, we noted that the information encoded at the time of attempted recall may overlap, not only
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with the record containing the required information, but also with
records containing other information, and that the probability of the
required information being recalled would be reduced if these related but
incorrect records were activated to a sufficient degree (p.210). An
implication of this is that recall may be improved by measures which
decrease the overlap between the relevant record and records containing
related information - measures which, put another way, increase the
distinctiveness of the relevant record (Eysenck, 1979; Jacoby & Craik,
1979, Craik, 1979). In order to increase the distinctiveness of a
record, we need to manipulate the associated information contained in the
record. Simply increasing the amount of this information (i.e. straight­
forward elaboration - p.212) may often render the record sufficiently
distinctive. However, such a strategy may not be effective if the
encodings of different but related items of required information are
elaborated in similar ways. The strategy would make the records more
elaborate, but not more distinctive. Rather, the recall of the items may
be better facilitated by elaborating on each item of information in a
different way, and by including in the elaboration some uniquely
identifying information. For example, in trying to remember the places
of work of various people encountered at a meeting (e.g. Peter works at
St Mary's Hospital; Mary at St Peter's; Mark at St Paul's), rather than
elaborating upon the information in the same general way or including the
same information in two or more elaborations (e.g. Peter has worked with
Paul Brown who works at St Mary's; Mary has worked with Brian Green who
works at St Peter's; Mark has worked with Brian Brown who works at
St Peter's), it may be more effective to elaborate in a different general
way for each item and to incorporate unique information in each
elaboration (e.g. Peter has worked with Paul Brown who works at St
Mary's; Mary helped raise money for the new scanner at St Peter's; Mark
lives opposite St Paul's).

In the experimental research, the effects of making the record more
distinctive and the effects of making it more elaborate have often been
confounded. Measures to make the record more elaborate may also make it
more distinctive, and measures to make it more distinctive may make it
more elaborate. Much of the evidence cited earlier concerning the
effects of elaboration and of structuring devices is confounded in this
way. This does not mean that the procedures used in this evidence are
ineffective, but rather that the explanation of how they have their effect is uncertain. Though it is difficult to find any empirical evidence to support the claim that unstructured elaboration can have an independent effect, a case can be made for claiming that the other two factors (i.e. distinctiveness and structure) can have such an effect. In the case of structuring devices, the arguments about how these might have their effect (p.213) were based more on logic and uncontroversial assumptions (e.g. that it is easier to learn less information), than on any particular theoretical model of recall. The claim that they can be effective has much intuitive appeal. For example, it is intuitively doubtful that rearranging the initial letters of the first nine elements in the periodic table in a random order (e.g. BFNCLiHeHBO) would facilitate recall to the same extent as their arrangement in the appearance of a name (H.HeLiBeBOFO).

There is some empirical evidence that distinctiveness can have an effect which is independent of elaboration. For example, Stein (1978) presented subjects with lists of 24 words. One group was asked semantic questions for 20 of the 24 words and typescript questions for the remaining 4 words. The other group received 20 typescript and 4 semantic questions. Performance on a subsequent recognition test was better for those words belonging to the groups of four. This effect is presumably to be attributed to the distinctiveness of their encodings, since the degree of elaboration was held constant across the groups. There is also circumstantial evidence supporting the independence of distinctiveness (Eysenck, 1979). For example, it readily explains the phenomenon of interference in memory tasks (Jacoby & Craik, 1979). 'Interference' refers to the fact that the recall of information tends to be impaired by the prior or subsequent encoding of other information, particularly information of a related nature (Wingfield & Byrnes, 1981) (cf. p.211).

It has been claimed that semantic encoding is more effective than encoding in terms of the physical attributes of stimuli (Craik & Lockhart, 1972; Craik & Tulving, 1975). However, this cannot be accepted without qualification. Evidence suggests that it has neither universal nor overall superiority. For example, there is evidence that when the information required at recall concerns the physical attributes, then, consistent with the model of recall described earlier (p.210), recall is

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better when the experimental manipulations have encouraged physical rather than semantic encoding (Morris et al., 1977; Bransford et al., 1979). On the other hand, there is also evidence that the combination of semantic encoding and semantic testing can produce better recall than physical encoding and testing (Morris et al., 1977; Fisher & Craik, 1977, Craik, 1979). To explain this result, it has been suggested that learners typically produce spontaneous semantic elaborations more readily than spontaneous elaborations on physical attributes (Craik, 1979; Jacoby & Craik, 1979). This may be because, due to the nature of everyday processing, they have more practice at it (Bransford et al., 1979; Anderson & Reder, 1979), or because the scope for elaborating with reference to the physical attributes is more limited. We might also suggest that the semantic encoding of input may often constitute a more abstract form of encoding which, being shorter, may more readily be recalled (p.213). For example, it may be easier to recall a brief verbal description of a meaningful scene represented in a picture, than to recall a necessarily complex representation of the scene in terms of its physical attributes. Consistent with this suggestion, recall for meaningful pictures which the learner can encode and elaborate upon semantically, tends to be far more effective than recall for pictures which cannot readily be dealt with in this way (e.g. pictures of snowflakes (Goldstein & Chance, 1971).

Eliciting Teaching Trial Recall

Repeated encodings of the required and associated information strengthen the connections in the record and thereby increase the probability of recall (p.210). This has the obvious and well-attested implication that the probability of recall is increased by repeated presentations of the information (Wingfield & Byrnes, 1981). However, there is evidence that information is more likely to be recalled by subjects if they have recalled it on previous occasions, than if it was simply presented to them on those occasions (Lachman & Laughery, 1968; Allen et al., 1969; Lachman & Mistler, 1970; Gotz & Jacoby, 1974). For example, Lachman and Laughery (1968) demonstrated that the inclusion of a series of recall tests in a learning sequence resulted in better performance on a final recall test than the inclusion of an equal number of trials in which the information was simply presented to the learner.
without any requirement for recall. The research further suggests that the beneficial effects of earlier recall on subsequent recall are greater if the information was initially recalled with difficulty than if it was recalled with ease (Craik, 1970; Gardiner et al., 1973; Jacoby & Craik, 1979). For example, Gardiner et al. (1973) observed that words recalled quickly and easily in the immediate aftermath of a presentation were less likely to be recalled on a subsequent test than words which were recalled with difficulty (difficulty being measured by the length of time it took to recall the word). In summary, then, unassisted recall may be facilitated by inducing the learner to recall the information on the preceding teaching trials (rather than simply presenting it), and by making the teaching trial recall difficult rather than easy.

These findings can be explained in terms of the model we have offered (Jacoby & Craik, 1979). If the required information is simply re-presented, the learner may not encode it. By contrast, recalling the information guarantees that it is encoded again. Given that repetition of the information will have an effect only if it is re-encoded (p.209), this gives recall an advantage over re-presentation. Furthermore, even if the re-presented information is encoded, the accompanying elaboration in terms of associated information may not be as extensive as the elaboration that occurs when the information is recalled. For the need to recall may induce the learner, in attempting to retrieve the required information, to encode associated external input or internally-generated information (p.210) to an extent not necessary if the task is simply to encode the re-presented information. Given that the degree of associated information that is encoded (i.e. the degree of elaboration) is a determinant of unassisted recall (p.212), this, too, gives recall an advantage over re-presentation. This argument also explains why recalling with difficulty may facilitate subsequent recall more than recalling with ease. When learners are finding it difficult to recall information, they are more likely to engage in more elaboration in an attempt to access that information (p.210). Indeed, even if the learner does not deliberately elaborate in an attempt to facilitate recall, recall (and difficult recall even more so) may nevertheless still result in greater elaboration. For the extent to which an input is elaborated is presumably dependant on the degree of attention given to that input (p.211). Familiar input (such as the re-presentation of the information)
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is likely to be given less attention (p.97), and therefore to be elaborated less.

How, then, are we to induce recall of the required information on the teaching trials? Improving the quality of the initial encoding in the ways discussed will help. We can also briefly mention a number of other measures:

- Recall takes time, and generally the more difficult it is, the more time it takes (Gardiner et al., 1973). A necessary condition, then, for the occurrence of teaching trial recall is that the learner is given sufficient time in which to achieve it.

- It is possible that, in some circumstances at least, the learner will benefit from an instruction to recall the information (e.g. "Try to remember what you have to do.").

- We noted that, because activation decays only gradually, information is more likely to be recalled if the attempt takes place before the activation has decayed completely (p.211). This suggests that recall may be facilitated by decreasing the interval between the initial presentation of the information and the attempt at recall.

- From the principle that the probability of recall is dependant on the degree of overlap between the information initially encoded and the information encoded at the time of attempted recall (p.210), it follows that teaching trial recall may be facilitated by keeping the circumstances of teaching constant from trial to trial.

Another measure requires more discussion. The model of recall that we have described postulates that the probability of recall depends on the amount of information in the relevant record that is activated at the time of attempted recall (p.210). This information is activated by the presentation of part of the required information, or some part of the associated information, which indicates that recall is required; and may be further activated by the learner's encoding of more of the associated information (or required information if it is available) (p.210). This suggests that we could facilitate recall by providing the learner with more of the relevant information or associated information. This procedure is known as retrieval cueing. Evidence from cognitive research attests to its effectiveness (Wingfield & Byrnes, 1981). For example, in an experiment by Tulving and Pearlstone (1966), the subjects were
presented with lists of words belonging to explicitly designated categories. Subjects who were given the category names at the time of recall outperformed those who were not. Similar results have been obtained when the subjects were individuals with a learning disability (Glidden, 1979). Research on the procedure has also revealed that such retrieval cues are more effective if the information in the cue was also presented at the time of the initial encoding (Tulving & Donaldson, 1972; Tulving & Thomson, 1973; Tulving, 1979). Again, this is consistent with the model we have described. If the information contained in the cue was also encoded in the initial record, then the subsequent encoding of the cue will activate part of the record in which the required information is encoded and this activation may be transmitted to the required information itself.

How are we to make the recall as difficult as possible? Some of the factors already discussed can be manipulated in order to increase the difficulty of recall. For example, we can increase it by decreasing the amount of information contained in the retrieval cues; by providing associated cues which do not match the information that was initially encoded; by varying the circumstances of learning; by increasing the length of time between teaching trials; and by teaching the learner associated tasks in the interim (thereby increasing the degree of interference – p.218). Maintaining the difficulty of recall over several teaching trials needs to be given special consideration. For if the conditions of recall are kept constant, then the more often the information is recalled, the easier its recall will become (p.210). This implies that the factors mentioned will need to be further manipulated in order to maintain the difficulty of recall. For example, there will need to be further reductions in the amount of information contained in the retrieval cues.

It is worth noting that recall should not be made so difficult that it is unlikely to occur. Although there is evidence that even a failed effort to recall can facilitate subsequent recall, this only happens when the learner is close to succeeding (this being indicated by the subjects' report that the word is 'on the tip of the tongue') (Gardiner et al., 1973). The frustration of attempts at recall which do not succeed may also have motivational countereffects.
In summary, then, it has been suggested that the unassisted recall of required information may be facilitated by measures to improve the quality of the initial encoding (elaboration, structuring devices and making the encoding distinctive), and by eliciting recall on the teaching trials rather than simply re-presenting the information. Teaching trial recall may, in turn, be facilitated by providing retrieval cues, by decreasing the interval between teaching trials, by keeping constant the circumstances of learning, and by instructing the learner to attempt recall. The learner also needs to be given time on the teaching trials in which to recall the information. Unassisted recall may also be facilitated by making the teaching trial recall as difficult as possible, consistent with its occurrence remaining probable. This can be achieved by manipulating in reverse those factors which can facilitate teaching trial recall. We turn now to consider the implications of this account for existing prompting practices and in terms of what novel procedures it might suggest.

7.3: A RECONSIDERATION OF ESTABLISHED PROCEDURES

Fading

In Chapter 6 (p.150) we noted that the rationale offered in the existing literature for the fading of response prompts is somewhat inadequate. Skinner (1968) maintained that reducing the control of such prompts by means of fading increases the control of the natural antecedents. However, he offered no satisfactory theoretical or empirical justification for this claim. We also noted some ambiguities in his account. Does the reduction in the prompt's control refer to its control over the overt response, over the necessary precursory behaviours, or both? Is a less controlling prompt one which is less likely to elicit the response in the actual circumstances of its application, or one which is less likely to elicit the response in the hypothetical circumstances in which the learner had received no prior training on the response? Most importantly, it is difficult to find in Skinner's work or elsewhere an account of those features of a prompt which determine the degree of control it exercises. Consequently, there is an absence of clear general guidelines about how the control exercised by the prompt can be reduced. Such guidelines as are offered (reducing
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assistance, reducing intrusiveness, etc.) are vague and contradictory
(p.163). There are also discrepancies between the basic rationale (that
fading should reduce control) and established fading practices
(particularly, the traditional physical-gestural-verbal hierarchy)
(p.164).

The cognitive account we have given can shed some light on these
issues. It was suggested that, in devising a prompting strategy, we
should be concerned, first to ensure accurate encoding of the relevant
information (i.e. understanding of the task requirements - p.89), and
then to ensure its unassisted recall (p.92). This implies that initially
the prompt should contain (or enhance) as much information as the learner
needs to understand the task requirements. Once the learner has grasped
these, the aim is to ensure unassisted recall. This can be facilitated
by eliciting recall on the teaching trials (p.219). One way of achieving
this, in turn, is the provision of retrieval cues (p.221). These should
contain part of the relevant information, or part of the associated
information encoded on previous occasions. The probability of unassisted
recall can be further increased by making the teaching trial recall as
difficult as possible, consistent with its occurrence remaining likely
(p.220). The difficulty of recall can be maintained across a series of
teaching trials by reducing the amount of information contained in the
retrieval cues (p.222).

On this basis, we can give a rationale for the fading of response
prompts. The procedure can be effective (i.e. more effective than the
continued presentation of the initial prompt) because recall on the
teaching trials can be more effective than the continued presentation of
the initial prompt, and the procedure permits and assists such recall
whereas the continued presentation of the initial prompt does not.
Unassisted recall may be further facilitated by making the teaching trial
recall as difficult as possible, and further fading the prompt serves to
maintain a reasonable level of difficulty across a series of teaching
trials. We can also give clearer guidelines about how prompts should be
faded. A faded prompt should take the form of a retrieval cue which
gives part of the relevant or associated information. Further fading
should take the form of gradually reducing the amount of information thus
given. This account lends support to the doubts raised about the
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traditional fading hierarchy (p.164). Fading requires a reduction in the amount of information given. This is not achieved by giving the same information in a different modality (e.g. by gesture rather than physically). In Section 7.4 we shall consider how these general guidelines about fading are to be translated into specific practice.

Delay

The cognitive account also provides a rationale for the use of prompt delay which supplements the somewhat limited rationales offered in Chapter 6 (p.167). Recalling the relevant information on the teaching trials may facilitate the emergence of its unassisted recall (p.219). Relative to the continued immediate presentation of the initial prompt, delaying the prompt increases the probability of teaching trial recall by giving the learner the time necessary for recall (p.221). Furthermore, because the procedure entails a delay in the delivery of reinforcement for a prompted response, the frustration involved in waiting for reinforcement may positively encourage the learner to attempt to recall (p.169).

A point of some importance is that the procedure gives the learner no informational assistance in attempting recall. Consequently, if the probability of unassisted recall is low, recall is unlikely to occur and the procedure is thereby unlikely to facilitate acquisition (except perhaps in the case of spurious prompts - p.152). Indeed, it may even be countereffective if the recall of incorrect information (i.e. an error) occurs (Section 6.4).

Delay vs Fading

In discussing the relative merits of fading and delay, we argued for the general conclusion that neither is likely to have universal or overall superiority over the other - that is, that in some circumstances one will have a greater effect, but in other circumstances the other will be superior (p.178). We also suggested some circumstantial determinants of this relationship (p.179). Consideration of their relative merits from the cognitive perspective lends further support to this conclusion and sheds further light on what circumstantial factors are likely to be
relevant. Thus we can suggest that their relative effectiveness depends on the probability of unassisted recall and thereby on the circumstantial factors which govern this probability (e.g. the stage of learning - p.159). As we noted in the previous paragraph, in circumstances in which unassisted recall is unlikely to occur, delay is unlikely to facilitate learning. However, fading, by providing retrieval cues, may succeed in these circumstances in eliciting recall, and thereby may facilitate learning. By contrast, when unassisted recall is likely, the informational assistance provided by the fading procedure may render the recall too easy, and delay may prove superior because it requires more effortful recall.

Errors

In Chapter 6 (p.189), we noted that there is empirical evidence that errors can be learned during training. An explanation of the occurrence of this in the context of choice discrimination can be offered in terms of adventitious reinforcement. Its occurrence in other contexts may be explained partly in terms of the reinforcing properties of prompts which correct errors. However, there is much evidence which cannot be explained in this way.

The cognitive approach provides the basis for an additional account of how errors may be learnt and may thereby interfere with learning. If an error occurs, then a record of its occurrence may be encoded and stored. This record will overlap with the record containing the correct information in many respects - for example, in respect of the associated information concerning the context of their occurrence. Consequently, the information encoded at the time of attempted recall may overlap with that contained in the erroneous record and, if so, will tend to activate the latter (p.210). If the latter receives sufficient activation, then it may be recalled instead of the required record. At best, this will delay the recall of the required information. At worst, it may prevent it if the information is not recognized as erroneous, or if its recall has inhibited recall of the relevant information (p.211). This account is quite general - that is, it may have application whatever the type of task or learner involved. Consequently, we can offer it to account for the reported instances of error learning which, it was argued (p.190),
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cannot be explained in terms of the hypotheses described in Chapter 6.

The account can also predict the nature of the errors that are likely to occur. Since the recall of erroneous information is dependant on the activation of the record containing it, and this in turn is dependant on the degree of informational overlap with the record containing the correct information, those erroneous records which contain a significant informational overlap are more likely to be recalled (p.211). In other words, errors are more likely to be responses which are related to the correct response in some significant way than to be unconnected.

The account also provides guidance about the circumstances in which errors are likely to be learned in this way, and about what action to take in order to avoid or remedy the problem. The probability of an error being recalled is presumably dependant on the same factors which govern the recall of any information. Consideration of these factors may help us to predict their occurrence, and their manipulation to avoid or remedy the problem they cause. We have described some of these factors in Sections 7.1 and 7.2. Two merit particular attention - repetition and distinctiveness. Repeated recalls of information increase the probability of its subsequent recall (p.209). This implies that the more often errors are repeated, the more likely they are to interfere with learning. The need to avoid repeated errors was also indicated by our discussion of their motivational countereffects (p.188). In the case that different but related items of information are being learnt, interference amongst the different responses, and consequent errors, are particularly likely (p.211, p.218). This may be prevented by increasing the distinctiveness of each record - that is, by elaborating upon each item in a different way, or by including in the elaboration some uniquely identifying information (p.217). It is also important to note that a recalled error is not necessarily emitted as an overt response. The learner may recall that it is indeed an error, and consequently, instead of making an overt response on the basis of it, attempt to recall the correct response (p.211). The probability of the learner recalling that a response is incorrect is again presumably dependant on the same set of factors which determine the recall of any piece of information. This suggests that when an error has been learned or is at risk of being learned, then a promising course of action may be explicitly to teach the
Partial Task Training

The cognitive account suggests some additional advantages that partial task training may have over whole task training (p.204). When all the components are being learnt on each trial (i.e. whole task training), there is a possibility that the records of similar components will overlap to such an extent that they interfere with each other during recall, and thereby delay or inhibit the recall of the correct information, or cause errors (p.211, p.218). The recall of well-learnt information is presumably less susceptible to interference. Therefore, if each component is well-learnt before another component is introduced into the training (i.e., partial task training), interference with the recall of the previously acquired component may be less likely to occur. Furthermore, relative to whole task training, partial task training reduces the attentional demands made by other task components (p.205). This means that more attention is available for learning the targeted component. This is particularly so when the other task components have to be emitted simultaneously or immediately before or after the targeted component (p.203). It may also be the case when the task is fairly demanding and, if whole task training were used, the learner would find it difficult to sustain an adequate level of concentration throughout (p.203). However, the degree of attention allocated to an input probably determines the degree of elaboration conducted, and may determine the probability of storage (p.211). Since both of these, in turn, determine the probability of recall, partial task training may have an advantage in this respect.

7.4: NOVEL PROCEDURAL IMPLICATIONS

The cognitive account also provides a rationale for a range of procedures which are relatively novel - that is, they have not been suggested in the existing literature, or they have been suggested but rarely applied or investigated. We discuss these with reference to the quality of the initial encoding, and the elicitation of recall on the teaching trials.
The Quality of the Initial Encoding

The research on the effects on recall of the quality of the encoding has been conducted primarily in the context of memory for propositional knowledge. For reasons explained in Chapter 1 (p.16), a particular emphasis is placed in this thesis upon the acquisition of perceptuo-motor skills. This does not pose any significant theoretical obstacles to the use of this research to generate ideas about how better to teach perceptuo-motor skills. The model of memory is held to be general to the encoding and retrieval of all types of information. However, it does suggest that we need to indicate how the general principles about the quality of encoding that we have discussed are to be translated into specific prompting procedures for teaching perceptuo-motor skills.

In Section 7.2, we suggested two forms which unstructured elaboration might take. The first form involves assimilating the required information to the learner's existing knowledge (p.212). This suggests that, in the context of perceptuo-motor skills, it may be advantageous to encourage the learner to assimilate a new skill to existing skills of a similar nature. This might be achieved by interspersing trials on the new skill with performance on the old skills, or by verbally indicating the similarity to the learner. For example, it may promote unassisted recall if the learner's attention is drawn to the fact that the action required in rotating the arm of a can-opener is similar to the previously-acquired action of turning a key or winding a clock. Again, in teaching sight-reading, it may help to draw attention to the similarity between a new word and words which the learner can already read. Indeed, some reading schemes make use of this technique by, for example, teaching words which begin with the same syllable at the same time. However, in encouraging such elaboration, one must beware of the risk that related, but different, items become confused - that their encodings become non-distinctive. This is less of a problem in the motor example given, since the tasks and the circumstances of their completion are very different in other respects and the distinctiveness of the respective encodings is thereby ensured. It is most unlikely, for example, that a learner, having wound the can-opener would then place it by their bedside and get into bed (i.e. confuse it with a clock). However, in the case of sight-reading, the items and the circumstances
have much more in common. More distinctive encodings might be achieved in this case by explicitly teaching the differences, as well as the similarities, between the items (p. 227).

The second form of elaboration involved encoding information about the external context in which the required information is presented—that is, about the other aspects of the task, and the circumstances in which the task is performed (p. 212). In describing the model of recall, we noted that the need to recall the required information will be indicated to the learner by the presentation (either external or internal) of part of that information or part of the associated information—or, put another way, by the occurrence of discriminative stimuli for the corresponding response (p. 210). For many responses, there are several discriminative stimuli which indicate that the response is appropriate in the circumstances. In some cases, the discriminative stimuli will be objects or people towards which the corresponding response has to be directed (e.g. seeing someone you know is a discriminative stimulus for saying hello to that person). In other cases, the corresponding response will not be directed towards the discriminative stimulus (e.g. a school bell does not elicit some action directed towards the bell). In the former case, the discriminative stimulus will be part of the required information and therefore the learner will be explicitly taught that the stimulus is discriminative for that response. This will often be so in the latter case as well. However, since the action is not directed towards this type of discriminative stimulus, the response can be successfully taught without teaching the learner that the stimulus is discriminative for the response. Teaching about the stimulus towards which the response is directed will be sufficient to elicit the response in the learning situation.

However, this is an unsatisfactory strategy to adopt (though one

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1 It is likely that the practice of drawing attention to the similarities between a new skill and existing skills, as well as promoting recall, may also assist the learner to understand what is required in executing the new skill (i.e. to encode the required information accurately).
which is all too common). If the only discriminative stimulus for the response is the task stimulus towards which the response is directed, then recall of the required information will be cued only by the presentation of the task to the learner. This is sufficient in the learning situation. However, it will often not be sufficient to ensure an adaptive use of the acquired skill in everyday conditions in which the appropriateness of the response may be indicated by the occurrence of discriminative stimuli even in the absence of the task stimulus (i.e. generalization may be impaired). For example, the use of an acquired leisure skill in everyday life will be unnecessarily restricted if it is dependant on the learner catching sight of the relevant task materials. Moreover, even in the learning situation, the stimulus towards which the response is directed may not always be the most reliable indicator of the appropriateness of the response. Chained responses are an important example of this. The most reliable indicator of the appropriateness of a response in the chain is often not the stimulus towards which the response is directed, but the previous step and its outcome (p.47, p.158). Their importance derives from the fact that they will always occur, and will always have a high attentional value (except when the execution of the response becomes automatic (p.87)). Further, they will often be the only cue available which indicates that one particular response, rather than any of the other response in the chain, is required (since the stimulus towards which the response is directed may be present throughout the task). Moreover, in perceptuo-motor chained responses which do not involve manipulation of, or action directed towards, some object (e.g. solo dancing) there is no stimulus towards which the response is directed.

These considerations suggest that a preferable strategy may be to determine all those stimuli which are reliable indicators of the need for the response, and then explicitly to teach their role to the learner. Even though they may not constitute a necessary part of the required information (i.e. even though the learner could reliably perform the task without knowledge of them), it may be advantageous to encourage the learner to include them in the associated information (p.209) as part of the elaboration. As well as the avoidance of the problems described in the previous paragraph, this has the added advantage that a more elaborate encoding may be more likely to be recalled (p.212). For
example, in teaching chained responses, it may be advantageous to draw
the learner's attention explicitly to the relationship between the
previous step and the subsequent step. For example, we might use a
verbal commentary to achieve this (e.g. "Now that the tape is in, you can
press the button to make it play."), or we might ask the learner
questions about the sequence of steps. We should also ensure that, at
least on some occasions, there is temporal contiguity between the two
responses, since such contiguity may help establish the connection
(p.158).

Similar arguments can be used to suggest that, with respect to those
discriminative stimuli towards which the response is directed, it is
preferable to teach several of these, rather than to confine the
instruction to one of them, even though the latter strategy may be
sufficient to ensure reliable performance of the response in the learning
situation. For the single stimulus that has been selected may not always
be readily noticed by the learner in all the everyday situations in which
the response is appropriate. Moreover, a more elaborate encoding may
result in better acquisition. For example, in teaching the learner a
particular route (e.g. from home to school), it may better to teach, at
each critical point in the journey, a range of cues which discriminate
the correct way, rather than just one. For example, rather than simply
instructing the learner to turn left at the bottom of the road, it may
improve acquisition if attention were drawn to additional discriminating
features (e.g. "Turn left and walk towards the shops").

The use of structuring devices (p.213) to facilitate recall has
particular application in the teaching of chained responses. We noted
earlier (p.214) the suggestion that experienced practitioners use
'scripts' to assist in their implementation of such responses. These
scripts are hypothesized to be organized into 'scenes', each scene
dealing with a particular block of steps. We suggested that one of the
ways in which such scripts might facilitate the implementation of such
responses is that recall of the scene 'titles' may facilitate unassisted
recall of the required information. For the titles of the scenes are
abstractions and, as such, may be easier to recall. Furthermore, when
the order in which the specific steps are emitted is important, the
abstraction may assist in the correct recall of the required sequence by
ensuring that each scene is completed before the next one is begun. The implication of this for prompting chained responses is that it may facilitate their acquisition if the learner is explicitly taught a script of this nature.

It is worth considering this strategy in more detail. The goal-oriented nature of chained skills suggests that the basis for grouping the specific steps into scenes should be the general goal which a block of specific steps are designed to achieve. A description of the general goal also provides a suitable title for the scene. For example, the script for using a restaurant might include the scene titles (general goals) of finding a table, ordering the meal, eating the meal, and paying the bill. Learning these general goals may assist in the recall of the specific steps, and in ensuring that they are carried out in the correct order (e.g. that one does not leave before paying the bill).

In Chapter 3 (p.84), it was also suggested that we should explicitly teach about the goal of responses. In that context, the reference was to the specific goal of each response. The present discussion suggests that it may be useful to teach, not only this, but also the general goal of a block of related responses. One of the advantages of explicitly teaching about the specific goal of a response is that it enables the learner to implement the skill even when it requires non-identical movements on different occasions of its application (p.85). Thus it permits a greater generalization of the skill across different circumstances. Teaching the general goals of a skill may enhance its generalization still further. For the learner can use such knowledge, in conjunction with existing knowledge and skills, to generate a novel response to suit a novel situation (p.215). Failing this, knowledge of the general goal may at least facilitate the subsequent learning of such a response. For example, the knowledge that one must order food in a restaurant may enable the learner who has experience only of table service, to emit the required response when faced with a situation in which the food has to be ordered from the counter, or at least may assist the learner in learning the new response.

We noted earlier that another reason why a structuring device may be easier to recall than the required information (and therefore may
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facilitate unassisted recall) is that it may possess a strong internal structure such that the recall of one part strongly cues the recall of the other parts, if necessary in a specific order (p.214). For verbally encoded devices, the internal structure can be supplied by such things as meaning, grammar, rhythm, rhyme and musical intonation. The use of such devices is not uncommon in the teaching of perceptuo-motor skills to children. For example, a set of verbal instructions with a strong rhythm is often used to teach road-crossing skills (e.g. "Look right, look left, look right again. If all clear, walk straight across."); and children are sometimes taught how to tie a particular knot by means of a story, each part of which corresponds to some action in tying the knot.

Another suggestion we made was that the semantic encoding (in this context, more specifically, the verbal encoding) of a stimulus or response may sometimes constitute a more abstract form of encoding which, being shorter, may be easier to recall (p.219). This suggests that, in some circumstances, recall may be facilitated by providing the learner with a 'shorthand' verbal label for some stimulus or response which would otherwise require a complex encoding. For example, Annett (1989) describes the practice of squash coaches who teach their pupils to adopt a particular stance when receiving serve by instructing them to pretend to be a Red Indian on the warpath. Encoding the required response in this way may assist the learner to recall it on subsequent occasions. The example also illustrates the value of assimilating new skills to existing skills (p.229). Again, too, the strategy may have assisted the learner in encoding the required information accurately (p.230).

Eliciting Teaching Trial Recall

We have suggested that fading response prompts should take the form of providing part of the relevant information, or providing cues which are associated with that information (p.224). Since the typical fading procedure involves the presentation of the same information in a different modality (p.225) these general guidelines, and the account which gave rise to them, suggest some relatively novel methods of fading. One of these is of particular interest in that it is used in some of the empirical studies described in the next chapter. It takes the form of giving the learner a choice amongst alternatives, one of which is the
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correct response (e.g. "Do you play 3 or 4 cards on a King?"). Such prompts constitute a recognition test. They still require the learner to access the relevant record and to retrieve the required information. However, retrieval is more likely because the required information is already given (Jacoby & Craik, 1979) - in other words, recognition is easier than recall, a claim which is empirically well-supported (Wingfield & Byrnes, 1981). Insofar as they offer substantial assistance to the learner in the process of retrieval, such prompts may be of particular value in circumstances in which retrieval is relatively difficult for the learner.

In providing fading prompts (i.e. retrieval cues), it is important to avoid the use of what may be termed 'spurious cues' - that is, cues which permit the learner to determine the required information by some means other than its retrieval from the relevant record in memory. For example, for the response described in the previous paragraph, the prompt, "It comes after the number 3", would constitute a spurious cue because it permits the learner to determine the correct response (4) without gaining access to the file in which it is recorded that four cards must be played on a King. Spurious cues are to be avoided because the retrievability of information in a record will be enhanced by prior recall only if that recall involves obtaining the information from that record (Jacoby & Craik, 1979).

From the principle that the probability of recall is dependant on the degree of overlap between the information initially encoded and the information encoded at the time of attempted recall (p.210), it follows that teaching trial recall may be facilitated by keeping the circumstances of teaching constant from trial to trial (p.221). Conversely, varying the circumstances of teaching provides a way of maintaining the effort required for recall (p.222). These notions suggest the procedure of keeping the circumstances of teaching constant in the earlier stages of learning, but then introducing variation in the later stages. Interestingly, this subsequent variation could also be used to serve the need to train for generalization by using different versions of the task, different teachers and different situations (Stokes & Baer, 1977).
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It was suggested that teaching trial recall may be facilitated by decreasing the interval between the initial presentation of the information and the attempt at recall (p.221). This provides the basis for a justification of the suggestion made by Engelmann and Carnine (1982) to the effect that partial task training should be used in order to permit the rapid repetition during training of a motor response whose topography is new to the learner (p.203). The account we have given also justifies their additional claim that, when teaching trials are juxtaposed in this way, other activities should eventually be interposed between consecutive trials and the complexity of these other activities should gradually be increased. The effect of this will be to increase the length of the interval between trials and to increase the interference from other learning. Both of these, we noted (p.222), are ways of maintaining the difficulty of recall across a series of trials.

Indeed, the cognitive rationale suggests a wider application of the procedure suggested by Engelmann and Carnine. It suggests that the probability of recall may be facilitated in the earlier stages of learning by massed practice, and the effort of recall maintained throughout learning by introducing spaced practice during the later stages. This applies to all types of response, not just to motor ones; and to whole task training, as well as to partial task training.

Skinner (1968) and Wilcox and Bellamy (1982) suggested interposing increasing amounts of time, not between trials, but between the delivery of the prompt and the learner being permitted to act upon the prompt. Skinner offers this as a way of reducing the control exercised by the prompt. The cognitive account offers a more explicit rationale. If there is an interval between the delivery of the prompt and acting upon it, then, in order to act upon the prompt, the learner will have to recall the information it contains at the end of the interval. Provided that the prompt contains some of the relevant information, then such recall will constitute an act of recalling at least some of the relevant information, and, as such, it may facilitate the eventual independent recall of this information. Moreover, the longer the interval, then, typically, the greater will be the effort required to recall it (p.222) - which justifies the suggestion that the interval between prompt and action should be gradually increased.
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Another claim made earlier is that recall on the teaching trials might be facilitated in some circumstances by instructions to attempt such recall (p.221). It is difficult to find explicit examples of such instructions in the existing research literature. However, some studies have reported the use of prompts which may have indirectly encouraged the learner to attempt recall. For example, one of the prompts used in the study by McDonnell (1987) was "What do you do now?". It should be noted that such instructions might be expected to have an effect only if the learner would not otherwise have attempted recall, and if their attempts are likely to have some success.
CHAPTER 8: PROCEDURES - EMPIRICAL INVESTIGATIONS

The empirical investigations reported in this chapter tested the effectiveness of some of the established procedures which lack any significant empirical support; and some of the novel procedures described in the previous chapter. Studies 5, 6, 7 and 8 investigate fading (8.1); Studies 9 and 10 delay (8.2); Studies 11 and 12 explicit instructions to recall (8.3); and Studies 13 and 14 structuring devices (8.4).

8.1: FADING

In Chapter 6 (p.154) we noted the lack of studies which have tested whether the fading of response prompts can be effective. Studies 5, 6 and 7 provided such a test. The form of fading investigated was the one implied by the cognitive account of fading - namely, a reduction in the amount of information given (p.224). In each study, only an initial prompt and one faded prompt were used in the fading procedure. The studies thus provided a test only of the hypothesis that a reduction of the informational value of a prompt can facilitate acquisition. They do not provide a test of the additional hypothesis that further reductions in the information provided can further facilitate acquisition (p.224).

To claim that fading can be effective is to claim that a prompting strategy which includes fading can be more effective than a strategy which continues to present the initial prompt but is otherwise identical (p.11). In all three studies, the participants were initially trained using prompts which gave fairly full information about the task. At staggered intervals, the full prompt was replaced by a faded prompt (i.e. one which supplied less information), the strategy otherwise remaining the same. The effectiveness of fading was indicated by any relative improvement in performance following their introduction.
8.1.1: Study 5

Method

Two people took part in Study 5. The first was a 40 year old man, resident in a hospital for people with learning disabilities (p.113). On the Merrill-Palmer Scale of Mental Tests (Stutsman, 1948), his age-equivalent score was 33 months. On the Vineland Social Maturity Scale (Doll, 1965), his social age equivalent was 3.5 years. He had a severe hearing loss which made verbal communication very difficult. The second participant was a 42 year old man. On the British Picture Vocabulary Scale (Dunn et al., 1982), his age equivalent was 3 years 3 months, and, on the Vineland Scale, 2.9 years.

Each participant was taught the same three tasks - making a sandwich, making a cup of coffee, and washing and drying the crockery used. On the basis of an initial assessment of the first participant's abilities in respect of the tasks, the tasks were analysed into steps which also constituted the teaching targets. When the step involved measuring out some quantity (i.e. of water, coffee, milk or detergent), the accuracy with which the quantity was measured was not taken into account when rating whether or not the learner had completed the step correctly. For the purposes of the experimental design, these steps were grouped into two blocks, each of ten steps. The teaching targets, the order in which they were taught, and the grouping into blocks were as follows:

Block A
1. Remove bread from wrapper
2. Spread margarine on bread
3. Spread peanut butter on bread
4. Fold bread over
5. Fill kettle
6. Replace lid
7. Put lead into kettle
8. Put lead into wall socket
9. Switch on at wall socket
10. Press switch on kettle
Block B

11. Put coffee into mug
12. Replace lid on coffee jar
13. Pour in water when boiled
14. Add milk
15. Turn on tap
16. Squeeze some detergent into water
17. Roll up sleeves
18. Place crockery and cutlery into bowl
19. Wash items with brush
20. Dry items

The same forms of prompt were used for both participants. The initial full prompts consisted of the teacher modelling the required response - that is, the teacher performed the response using the task materials and then invited the learner to do likewise. The faded prompts consisted of the teacher pointing to the item which the participant needed to manipulate in order to complete the required response. For example, the faded prompt for replacing the lid of the coffee jar consisted of the teacher pointing to the lid, and pointing to the wall socket was the faded prompt for switching on the socket. Such pointing prompts were assumed to provide less information about the required response than the modelling, in that, whereas the latter gave information both about what to manipulate and how to manipulate it, the former only gave information about what to manipulate.

The same procedure was used for applying the prompt regardless of the type of prompt or the participant. Thus the prompt was given after an incorrect response, or after 5 seconds of task-irrelevant behaviour or doing nothing. The 5s interval began immediately after the feedback had been given for the completion of the previous step in the chain or, in the case of the initial steps of the three tasks, immediately after a general instruction had been given to begin the task. After each task-related response the learner was given feedback about its correctness. Sessions were conducted weekly, and there was one trial per session.

The experimental design was a multiple baseline across tasks and
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participants. Both participants received full prompts for the first two trials for both blocks of steps. For the first participant, faded prompts were introduced for the steps of Block A on the third trial, and for the steps of Block B on the sixth trial. For the second participant, they were introduced for the steps of Block B on the third trial, and for the steps of Block A on the sixth trial. This reversal of the points at which the fading procedure was introduced was intended to introduce some measure of experimental control over the fact that the two blocks of steps may not have been of equal difficulty.

The method for assessing the reliability of the dependant measures and procedural accuracy was the same as that described for Study 3 (p.138). Four randomly selected trials were videotaped. The interrater reliability was 98% for the dependant measures, and 99% for the ratings of the teacher's implementation of the procedure. The accuracy index was 99% for the form of prompt, and 91% for the timing (i.e. 91% fell within 1 second of the specified time - p.138).

<table>
<thead>
<tr>
<th>TABLE 8.1: RESULTS OF STUDY 5</th>
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<table>
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[The table shows the number of steps completed independently. Trials to the left of the broken line were conducted under the No Fading procedure, trials to the right under the Fading procedure. An effect of fading was not expected until the trial after its initial introduction.]
FIGURE 8.1: RESULTS OF STUDY 5

Graph aggregates results: Top half combines results on Block A for the first participant (BA/P1) and Block B for the second (BB/P2); bottom combines Block B for the first and Block A for the second.

Graph shows the number of steps for which no prompt was required.

Effect of fading not expected until second trial after introduction.
The results for each individual are shown numerically in Table 8.1. Figure 8.1 provides a graphical presentation in which the results are added together for the two participants. It should be noted that an effect of fading was not expected in the trial during which it was initially introduced, since the effect of the teaching trial recall of an item of information is hypothesized to have an effect only on subsequent attempts to recall that information (p.219). The results for each participant did suggest some degree of association between the introduction of fading and a subsequent relative improvement in independent performance, particularly in the case of the first participant.

8.1.2: Study 6

Method

Three people took part in Study 6. The first was a 41 year old man. His age equivalent score on the British Picture Vocabulary Scale (Dunn et al., 1982) was 3 years 5 months. The second was a 42 year old woman whose age equivalent score on the BPVS was 3 years 4 months. The third was a 43 year old woman resident whose age equivalent score on the BPVS was also 3 years 4 months.

Each participant was taught to operate a cassette player. As in Study 5, the task was analysed into steps/teaching targets on the basis of a preliminary assessment of the abilities of the first participant with respect to the task. For the purposes of the experimental design, the targets were grouped into three blocks, each of three steps. The targets, the order in which they were taught, and their grouping into blocks was as follows:

Block A
1. Plug lead into cassette player
2. Plug lead into wall socket
3. Switch on at wall socket
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Block B
4. Press eject button
5. Insert cassette
6. Close lid

Block C
7. Plug headphones lead into player
8. Place headphones on head
9. Press play button

To facilitate the completion of the task, the play button was marked with white tape and the eject button with blue tape. In rating whether or not the participant had completed the step independently, some inaccuracy of responding was permitted. Thus, they were judged to have completed the step independently if they inserted the tape into the player regardless of whether it was inserted in the correct orientation. Pressing an incorrect button was also permitted provided that their next response was to press the correct button.

The form of the prompts and the nature of the procedure was the same as in Study 5. Thus the initial full prompts consisted of modelling the response and the faded prompts consisted of pointing to that part of the task that had to be manipulated. The prompts were given after an incorrect response, or after 5 seconds of task-irrelevant behaviour or of doing nothing. The 5-s interval began immediately after feedback for the previous response. However, an exception to this was made in the case of the second participant. Because of her habit of talking a great deal, prompts were sometimes necessary to bring her attention back to the task ("Let's finish doing this first."). In the event of her beginning to talk immediately after feedback for the previous response, the interval began immediately after this re-orienting prompt.

The experimental design was also similar to that employed in Study 5. Full prompts were given for all steps of the task for the first two trials, and then faded prompts were introduced at staggered intervals (on trial 3, trial 6 and trial 9) for the three blocks of steps. The order of introduction of the faded prompts relative to the blocks was varied across individuals in order to provide some degree of experimental
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control over the possibility that the blocks differed in ease of acquisition.

The reliability and accuracy indices (p.138) were calculated on the basis of six randomly selected videotaped trials. The interrater reliability was 100% for the dependant measure, and 94% for the teacher's implementation of the procedure. The accuracy index was 93% for the form of the prompt, and 96% for its timing.

### TABLE 8.2: RESULTS OF STUDY 6

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</table>

[The table shows number of steps completed independently. Trials to the left of the broken line were conducted under the No Fading procedure; trials to the right under the Fading procedure. An effect for fading was not expected until the trial after its initial introduction.]
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FIGURE 8.2: RESULTS OF STUDY 6

Graph aggregates results: Top third combines results on Block A for the first participant (BA/P1), Block B for the second participant (BB/P2) and Block C for the third (BC/P3) etc.

Graph shows the number of steps for which no prompt was required

Effect of fading not expected until second trial after introduction.
The results for each individual are shown numerically in Table 8.2, and Figure 8.2 provides a graphical presentation in which the results are summed for the three participants. It should be noted that, as for Study 5 (p.243), an effect of fading was not expected in the trial during which it was initially introduced. The results do not show any clear association between the introduction of fading and an improvement in performance. The design of the study may have contributed to this failure, in that the limited number of steps in each block reduced the opportunities for fading to facilitate the acquisition of a step and prevented any effect of fading occurring in the form of a significant increase in the number of steps completed independently.

8.1.3: Study 7

Method

The participant in Study 7 was a 41 year old man whose age equivalent score on the British Picture Vocabulary Scale (Dunn et al., 1982) was 3 years 5 months.

The participant was taught the card game known as 'Beggar-My-Neighbour'. This game requires a range of skills but, for the purposes of the study, the dependant variable was restricted to the participant's ability to state correctly the number of cards that he was required to play from his own stock of cards when his opponent played one of four penalty cards. Specifically, when his opponent played a Jack, he was required to state that two cards had to be played; for a Queen, three cards; for a King, four cards; and for an Ace, five cards. Prior to the commencement of the study, a check was made to ensure that the participant was able reliably to identify these four cards, and reliably to count out up to five cards. Also, the rules of the game were described and illustrated in some sample games.

Each session consisted of two probe trials and four teaching trials for each of the four penalty cards. These trials were conducted within the context of the teacher and the participant playing the game together.
When the teacher played one of the penalty cards (which, of course, occurred in a random order), either a probe or a teaching trial was administered. On the first occasion within a session that a particular penalty card was played by the teacher, a probe trial was administered (the 'pre-teaching probe'). On the next four occasions, a teaching trial was administered. On the sixth occasion of that card being played, there was a second probe trial (the 'post-teaching probe'). Sessions typically took place twice per week.

Three teaching procedures were used in the study. In the Full-Immediate procedure, the participant was given a full verbal prompt immediately the card was played (i.e. "For a Jack (Q, K or A), you put down 2 (3, 4 or 5) cards."). In the Full-Delayed procedure, the full verbal prompt was given after an error or, in the case that the participant made no response, after 4 seconds had elapsed. In the Fading procedure, a faded prompt was given immediately the card was played, and, in the case of an error or no response within 4 seconds, the full verbal prompt was given. The faded prompt consisted of a question asking the learner to choose between two numbers, one of which was correct - e.g. "Is it 2 or 5 cards that you put down for a Jack?". The incorrect option was chosen at random from the responses appropriate for the other three cards. The use of forced choice questions as a form of fading was discussed in Chapter 7 (p.234). We noted that, inasmuch as such prompts provide substantial assistance for the learner in attempting to retrieve the required information, they may be of particular value in circumstances in which recall is otherwise likely to be difficult. This was judged to be the case in the present study since the participant was required to learn a purely arbitrary association between a name and a number, and was required to learn several similar associations which may have interfered with one another (p.211, p.218).

The procedure for the probe trials was the same as that for the Full-Delayed teaching procedure with the exception that, instead of the full verbal prompt being given after an error or an interval of 4 seconds, the participant was asked the following question: "For a Jack (Q, K or A), you put down?...How many cards?". Feedback was given for any response, and the full verbal prompt given in the case of an error or no response.
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The dependent variable was the participant's response on these probe trials. He was judged to be incorrect if he stated an incorrect number, either before or after the question. He was judged to be correct after the question if he failed to give any response within 4 seconds but, upon questioning, stated the correct number. He was judged to be correct before the question if he stated the correct number within 4 seconds and had not first stated an incorrect number.

For the first two sessions, the Full-Immediate procedure was used in the teaching trials for all four penalty cards. In the third session, the Fading procedure was introduced for teaching two of the cards (selected at random), and the Full-Delayed procedure introduced for teaching the other two cards. The Full-Delayed procedure was introduced for the other two cards (rather than continuing with the Full-Immediate procedure) to ensure that any superiority of the Fading procedure could not be attributed to the delay component it contained.

The same form of prompt and the same, or similar, procedures were also used in teaching the same game in Studies 8, 9 and 11. Procedural accuracy and the reliability of the dependent measures were assessed on the basis of five video-taped sessions (one session from each of the studies and a fifth selected at random). Interrater reliability was 100% for the dependent measure, and the ratings of the teacher's implementation of the procedure. The procedural accuracy index was 100% for the form of the prompt, and 96% for the timing.

Results

The results are shown in Figure 8.3. The results strongly support the claim that fading can be effective. The Fading procedure was clearly more effective than the Full-Delayed procedure in the initial comparison - the former succeeded in teaching the responses, but the latter failed. Furthermore, the Fading procedure was then successfully applied in teaching the two responses which the Full-Delayed procedure had failed to teach.
FIGURE 8.3: RESULTS OF STUDY 7

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KEY:
- Pre-teaching
- Post-teaching
- Full Immediate
- Full Delayed
- Fading

CBQ Correct before question
CAQ Correct after question
I Incorrect
The participant's responses on the teaching trials confirmed the effectiveness of the faded prompts in ensuring the recall of the correct information. In response to the forced choice offered by the partial prompt, the participant made the correct choice on 84% of occasions; the incorrect choice on 5% of occasions; and no response on 10% of occasions. This contrasts sharply with his responses on the Full-Delayed teaching trials: He gave the correct response on 9% of occasions, an incorrect response on 28%, and no response on 63%.

The high rate of errors under the Full-Delayed procedure raised the possibility that, because of the errors, this procedure was, in fact, countereffective - that is, that it was less effective than the Full-Immediate procedure would have been. This, in turn, raised the possibility that the Fading procedure would not have been superior to the Full-Immediate procedure. If this were so, then it would be necessary to attribute the superiority of the Fading procedure to the Full-Delayed procedure to its lower error rate, rather than to any positive mechanism of effect. This issue was investigated in Study 8, which compared the effectiveness of the Fading procedure with the Full-Delayed procedure.

8.1.4: Study 8

Method

The participant in Study 8 was a 33 year old woman whose age equivalent score on the British Picture Vocabulary Scale (Dunn et al., 1982) was 6 years 5 months.

The pre-study assessment, the teaching targets, the procedures and the forms of the prompts were all the same as those in Study 7. The only differences were that some teaching of the names of the four penalty cards was required prior to the commencement of the study and, more importantly, on the third trial, although the Fading procedure was introduced for two of the cards (randomly selected), the Full-Immediate procedure continued to be applied for the other two cards. This latter difference was designed to test the hypothesis that the effectiveness of the Fading procedure in Study 7 was attributable to a positive mechanism of effect, rather than simply to the fact that it led to fewer errors.
than the Full-Delayed procedure.

Results

The results are shown in Figure 8.4. The Fading procedure was clearly more effective than the Full-Immediate procedure in the initial comparison phase, and it was subsequently used successfully to teach the two responses which the participant had failed to acquire under the Full-Immediate procedure. The results thus indicated that fading can have an effect on acquisition by means of some positive mechanism, rather than simply by avoiding or reducing the errors that may occur when delivery of the full prompt is delayed. What that positive mechanism might be, we have discussed in Chapter 7 (p.224).

The participant's responses during the Fading teaching trials again indicated the effectiveness of the faded prompts in ensuring correct retrieval of the required information. She made the correct choice on 92% of occasions, an incorrect choice on 4% and no response on 4%.

8.1.5: Discussion

The studies reported in this section were designed to test the hypothesis that fading, at least in the form of a reduction in the degree of information contained in the prompt, can facilitate acquisition. In Studies 5 and particularly 7, the results were clearly of the nature predicted by the hypothesis. Study 6 failed to support the hypothesis, but this may have been due to an inadequate design (p.247). Study 7 also indicated the effectiveness of a relatively novel way of fading the prompt - namely, forced choice questions (p.234), and Study 8 indicated that fading can operate by means of some positive mechanism of effect. One interpretation of the results in Study 7 was that the fading procedure was more effective because it allowed fewer errors, rather than because it facilitated acquisition by means of a positive mechanism. Study 8 disproved this interpretation. It is also inapplicable to the results of Study 5, since both the experimental and control procedures used in this study involved post-response prompting and therefore any difference in error rate between the two must have been due to a difference in the positive contribution made by fading.
FIGURE 8.4: RESULTS OF STUDY 8

<table>
<thead>
<tr>
<th>CBQ</th>
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KEY: 0-0 Pre-teaching trial  CBD Correct before question
      0-0 Post-teaching trial  CAO Correct after question
      FI  Full Immediate  1 Incorrect
      F   Fading

Sessions
8.2: PROMPT DELAY

As with fading, it is difficult to find studies which have provided an experimentally controlled test of the effectiveness of delaying the prompt (p.169). Studies 9 and 10 provide such a test. The appropriate control condition for testing the effectiveness of delay is one in which the same prompts are presented immediately (p.170).

8.2.1: Study 9

Method

The participant in Study 9 was a 45 year old man who obtained an age equivalent score of 5 years 6 months on the British Picture Vocabulary Scale (Dunn et al., 1982). The task taught was the card game used in Studies 7 and 8. The pre-study assessment, teaching targets, procedures and prompt forms were all the same as in those studies. (The participant required no prior teaching in naming the cards.) The Full-Immediate (p.248) procedure was used to teach all four responses in the first two sessions. In the third session, the Full-Delayed (p.248) procedure was introduced for two of the cards, whilst the Full-Immediate procedure continued to be applied to the other two cards.

Results

The results are shown in Figure 8.5. They failed to confirm the hypothesis that delaying the prompt can facilitate acquisition. Indeed, the performance of the participant appeared somewhat superior when the prompts were not delayed.

Because the targets were not reliably achieved under either procedure, the Fading procedure (p.248) was then applied to teaching the two responses which the Full-Delayed procedure had failed to teach, and the Full-Delayed procedure was applied to the two previously taught using the Full-Immediate procedure. This had two purposes. First, it provided a further test of the effectiveness of fading. Second, it provided a test of the hypothesis that, at least in some circumstances, fading can be more effective than delay (p.179, p.225).
FIGURE 8.5: RESULTS OF STUDY 9

Procedures - Investigations

<table>
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KEY: O-O Pre-teaching trial  CBQ Correct before question
I-I Post-teaching trial  CAQ Correct after question
FI Full Immediate  I Incorrect
FD Full Delayed  F Fading
The results of this subsequent phase of the study are also shown in Figure 8.5. They further demonstrate that fading can be effective, and they also offer confirmation of the claim that fading can be more effective than delay. It should be noted that Study 7 also provided confirmation of the latter claim, in that, there too, the Fading procedure proved more effective than the Full-Delayed procedure (see Figure 8.3, p.250).

Data from the teaching trials again indicated the effectiveness of the forced-choice fading prompts in eliciting teaching trial recall (p.251). The participant made the correct choice on 81% of occasions, the incorrect choice on 13%, and no response on 6%. This contrasts with the corresponding figures for the Full-Delayed trials (0% correct response, 16% incorrect response, and 84% no response). A similar high rate of errors under the delay procedure was obtained in Study 7 (the corresponding figures being 9%, 28% and 63% respectively). It will be recalled that some previous studies have also obtained high error rates with the procedure (Handen & Zane, 1987 - p.173).

8.2.2: Study 10

Method

Three people took part in Study 10. The first was a 42 year old woman who obtained an age equivalent score on the BPVS of 3 years 4 months, and the second was a 43 year old woman who obtained the same score. Both had taken part in Study 6. The third was a 45 year old man who obtained an age equivalent score on the BPVS of 5 years 6 months, and who had taken part in Study 9.

The study comprised two phases. In the first phase, the effectiveness of a progressive delay procedure was tested by comparing it with the immediate delivery of the prompt. In the second phase, the effectiveness of a constant delay procedure was tested in the same way. The comparisons were made in the context of teaching each participant four responses using the delay procedure, and four responses using the immediate procedure.
The participants were taught to name pictures of unfamiliar objects. The pictures were line drawings presented on 5"x3" cards. Sixteen pictures were used for each participant, four for each training condition. These were selected as follows: Each participant was shown pictures one at a time from a pool of 100 pictures and asked to name each one. This process continued until the participant had failed to name 24 pictures. These 24 pictures were then shown again to the participant. Each picture was immediately named by the teacher and the participant was asked to repeat the name. Any picture whose name the participant had difficulty in articulating was excluded. The remaining pictures were then allocated at random to the four conditions as follows:

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<th>Constant</th>
<th>Immediate</th>
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<td>crocodile</td>
<td>woodpecker</td>
<td></td>
</tr>
<tr>
<td>Part. 2</td>
<td>turkey</td>
<td>parrot</td>
<td>giraffe</td>
<td>crocodile</td>
</tr>
<tr>
<td>pineapple</td>
<td>sparrow</td>
<td>seal</td>
<td>volcano</td>
<td></td>
</tr>
<tr>
<td>kangaroo</td>
<td>woodpecker</td>
<td>skewer</td>
<td>eagle</td>
<td></td>
</tr>
<tr>
<td>flask</td>
<td>rhino</td>
<td>stag</td>
<td>celery</td>
<td></td>
</tr>
<tr>
<td>Part. 3</td>
<td>dolphin</td>
<td>skewer</td>
<td>peacock</td>
<td>kangaroo</td>
</tr>
<tr>
<td>igloo</td>
<td>crocodile</td>
<td>eagle</td>
<td>volcano</td>
<td></td>
</tr>
<tr>
<td>colander</td>
<td>rhino</td>
<td>ladle</td>
<td>stag</td>
<td></td>
</tr>
<tr>
<td>turkey</td>
<td>beaver</td>
<td>geyser</td>
<td>parrot</td>
<td></td>
</tr>
</tbody>
</table>

Each session consisted of two probe trials and four teaching trials for each of the pictures involved in that phase of the study. Within each session, all the trials for one training condition were administered before the trials for the other condition were given. The order in which the two conditions were administered was randomized across sessions. An interval of 10-15 minutes was interposed between the administration of the two conditions. For the administration of each condition, the pictures were shuffled and then shown individually for the pre-teaching probe. The cards were then shuffled again and the first teaching trial was administered. Three further trials were then given in the same manner, followed by a post-teaching probe. An interval of approximately 30 seconds was interposed between each trial. Sessions typically took place twice per week.
On the probe trials, the teacher showed the picture and asked, "What's this called?". In the case of a correct response, the participant was told, "That's right."; in the event of an incorrect response, the participant was told, "No. That's wrong."; and in the case of no response within 5 seconds, the picture was removed and the next picture shown. On the teaching trials, the picture was first shown to the participant. In the case of the Immediate procedure, the teacher immediately named the item and the participant was required to repeat the name. In the case of the Constant/Progressive Delay procedures, the teacher named the item after an incorrect response or, in the case of no response, after the interval required by the procedure. Again, the participant was required to repeat the name. In the case of a correct response, the participant was simply told, "That's right.". On all trials, the learner was, if necessary, prompted to look at a picture when it was presented. The interval began from the point at which the participant looked at the picture. In the Progressive Delay condition, the teaching trials in the initial session involved no delay. Provided that the participant did not give more than 4 incorrect responses on the 16 teaching trials given under the Progressive Delay condition in each session, the delay interval was increased by 1 second for the next session. In the case that this criterion was not met, the delay interval was decreased by 1 second for the next session. In the Constant Delay condition, the prompt was given immediately during the initial session, but thereafter the interval was 5 seconds. Sessions continued until the participant had named all four pictures correctly on a pre-teaching probe trial for either the Immediate or Delay condition. A follow-up session was also administered between 8 to 10 weeks following the end of the study. This took the form of a probe trial for all the pictures taught.

Reliability and procedural accuracy were assessed on the basis of videotapes of two sessions from the first phase of the study, and two from the second phase. Because of the greater importance of timing in this study, the teacher's timing of the prompt was required to be precise (i.e. the +1 second margin of error (p.138) was not permitted). The interrater reliability for the dependant measure was 99%; and for the ratings of the teacher's behaviour 90%. The accuracy index was 100% for the form of the prompt and 85% for its timing.
FIGURE 8.6: RESULTS OF STUDY 10

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Graph shows number of unprompted correct responses for each participant (Part.)
Results

The results are shown in Figure 8.6. They failed to support the hypothesis that delaying the prompt can facilitate acquisition. Visual inspection of the graphs shows no obvious differences between performance under the Delay procedures and performance under the Immediate procedure. This is confirmed by a numerical analysis. The percentage of correct responses made by each participant on all the probe trials in each condition was as follows:

<table>
<thead>
<tr>
<th>Part.1</th>
<th>Part.2</th>
<th>Part.3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1: Progressive</td>
<td>58%</td>
<td>60%</td>
<td>40%</td>
</tr>
<tr>
<td>Immediate</td>
<td>69%</td>
<td>75%</td>
<td>46%</td>
</tr>
<tr>
<td>Phase 2: Constant</td>
<td>43%</td>
<td>74%</td>
<td>61%</td>
</tr>
<tr>
<td>Immediate</td>
<td>28%</td>
<td>67%</td>
<td>61%</td>
</tr>
</tbody>
</table>

It will be noted that the mean percentage of correct responses was actually higher under the Immediate procedure than under the Progressive Delay procedure.

The responses of the participants on the teaching trials under the Delay procedures is also of some interest. These can be summarized as follows:

<table>
<thead>
<tr>
<th>Part.1</th>
<th>Part.2</th>
<th>Part.3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progressive: Correct</td>
<td>58%</td>
<td>84%</td>
<td>41%</td>
</tr>
<tr>
<td>Incorrect</td>
<td>24%</td>
<td>6%</td>
<td>20%</td>
</tr>
<tr>
<td>No response</td>
<td>19%</td>
<td>9%</td>
<td>39%</td>
</tr>
<tr>
<td>Constant: Correct</td>
<td>69%</td>
<td>63%</td>
<td>70%</td>
</tr>
<tr>
<td>Incorrect</td>
<td>28%</td>
<td>35%</td>
<td>16%</td>
</tr>
<tr>
<td>No response</td>
<td>3%</td>
<td>3%</td>
<td>14%</td>
</tr>
</tbody>
</table>

As in Study 9 (p.256), delaying the prompt was associated with a relatively high rate of errors (17% under progressive delay, and 27% under constant delay). It is also interesting to note that, even though they made many errors as a result, the participants waited for a prompt on relatively few occasions, particularly under the Constant Delay procedure (which obviously gave them more opportunity to respond). This corroborates the observation made by Striefel and Owens (1980) that, when the delay procedure is used, some individuals may anticipate the prompt with many errors rather than waiting (p.174).
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The nature of the errors made is also of interest. The great majority of these were repetitions of errors made earlier in the study. The precise percentages of total errors that were repetitions were as follows:

<table>
<thead>
<tr>
<th></th>
<th>Part.1</th>
<th>Part.2</th>
<th>Part.3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progressive</td>
<td>89%</td>
<td>75%</td>
<td>77%</td>
<td>80%</td>
</tr>
<tr>
<td>Constant</td>
<td>78%</td>
<td>72%</td>
<td>77%</td>
<td>76%</td>
</tr>
</tbody>
</table>

[These figures do not include the application of a correct picture name to the incorrect picture. Only the second participant made this kind of error (on 10% of occasions under the constant procedure)].

These data provide further evidence of the repetition and learning of errors which cannot be explained in terms of the notion that they have been adventitiously reinforced, and which it is implausible to interpret in terms of reinforcing properties of the corrective prompts that consequate errors (p.190). For the errors included in the table would never have been adventitiously reinforced during the course of the study, and the fact that all the learners eventually learned the correct responses undermines the interpretation in terms of them being reinforced by the corrective prompts. It is also of interest to consider the specific nature of these errors. They all fell into one of three categories - the name of an item which was semantically related to the item depicted (e.g. 'camel' for 'giraffe'); a like-sounding name (e.g. 'cauliflower' for 'colander'); or a like-sounding neologism (e.g. 'adle' for 'ladle'). The fact that the errors were related in some way to the correct response is consistent with the cognitive explanation that was suggested for the occurrence and learning of errors, namely that the information encoded at the time of attempted recall may activate, and lead to the recall of, records containing overlapping (i.e. related) but erroneous information (p.211, p.226).

8.2.3: Discussion

Neither study supported the hypothesis that delaying the prompt can facilitate acquisition. Of course, we cannot conclude from this that delay cannot in any circumstances facilitate acquisition. Such a conclusion would be warranted only if the circumstances of the study were ideal for the occurrence of such facilitation. With the benefit of the analysis of prompt delay in Chapter 7 (p.225), we can see that the
circumstances of these studies were far from ideal. For we suggested in Chapter 7 that the facilitatory effect of delaying the prompt is less likely to occur when unassisted recall of the relevant information (i.e. recall in the absence of the provision by the teacher of any information about the response) is unlikely (p.225). With reference to the card game used in Study 9, we noted earlier (p.248) that the participants were likely to require considerable assistance in recalling the information (particularly in the initial stages), given that the task involved learning arbitrary associations between a name and a number, and required the learning of several similar associations which were liable to interfere with one another. Similar remarks may be applied to the task used in Study 10. The studies thus offer some support to the suggestions made about the circumstances in which prompt delay is likely to be ineffective.

There are several other points of interest to emerge. First, Study 9 provided further evidence for the claim that fading can be more effective in some circumstances than prompt delay (see also p.256). Indeed, the circumstances of Study 9 matched the circumstances in which it was predicted that this superiority of fading is likely to hold - namely, circumstances in which unassisted recall is unlikely to occur on the teaching trials (p.225). If the effect of delay occurs by means of permitting and encouraging recall of the relevant information on the teaching trials, then, unless such recall occurs, delay will be ineffective. The low rate of correct anticipations (i.e. correct responses occurring before the prompt) in the two studies confirms that unassisted teaching trial recall was unlikely. Second, delaying the prompt was associated, in some cases, with poorer performance than the continued immediate presentation of the prompt. This was the case in Study 9; and in Study 10 performance was worse under the Progressive Delay procedure than under the Immediate procedure for all three participants. This offers some (very limited) support for our earlier contention that delaying the prompt may be countereffective in some circumstances (p.169). Third, the participants' performance under the procedure which continued to present full prompts immediately provides evidence that learning can emerge under such a procedure. This was particularly evident in Study 10. It thus supports the theoretical argument and empirical evidence that was put forward to dispute Skinner's
claim that learning will only occur if the control exercised by the
prompt is reduced in some way (p.153, p.154). Finally, both studies are
pertinent to the previous discussions about errors. They dispute the
claim sometimes made in the research literature that prompt delay is an
errorless or near errorless teaching procedure (p.173). In certain
circumstances (i.e. when unassisted recall is unlikely) a relatively high
rate of errors may occur. Finally, Study 10, in which the nature of the
ersors was recorded, also provided evidence for the learning of errors
other than by a process of adventitious reinforcement or by virtue of
some reinforcing property of the correction, and supported the cognitive
account of why errors occur and are learnt.

8.3: INSTRUCTIONS TO RECALL

One of the suggestions made on the basis of the cognitive account was
that explicit instructions to recall the required information (e.g. "Try
to remember what you have to do.") might increase the probability of
teaching trial recall and thereby facilitate acquisition (p.221, p.237).
Studies 11 and 12 tested the effectiveness of such instructions.

8.3.1: Study 11

Method

The participant in Study 11 was a 49 year old man who obtained an age
equivalent score on the BPVS of 3 years 10 months. The task taught was
the card game used in studies 7, 8 and 9, and the study was identical to
these earlier studies except in respect of the teaching procedures
compared. The study compared the Full-Delayed procedure (p.248) with an
Instructions procedure. In the latter, as soon as the card was played,
the teacher said, "Try to remember how many cards you have to put down
for a Jack (Q K or A).". In the case of an error or no response within 4
seconds, the full verbal prompt was given (p.248). It was thus identical
to the Full-Delayed procedure with the exception that it included
instructions to recall. As in the other studies, the first two sessions
employed the Full-Immediate procedure (p.248) for all four penalty cards.
In the third session, the Instructions procedure was applied to two of
the cards, and the Full-Delayed procedure to the remaining two.
Results

The results are shown in Figure 8.7. They do not support the hypothesis. The participant showed few signs of learning under either the Instructions or the Full-Delayed procedure.

The Fading procedure (p.248) was then applied to the two responses the learner had failed to acquire under the Instructions procedure. Again, this was intended to provide a further test of the hypotheses that fading can be effective, and that, at least in some circumstances, it can be more effective than delaying the prompt (p.256, p.262). The results provided some, albeit limited, support for these hypotheses. Though no fully independent performance occurred on the probe trials (i.e. the learner never gave the correct response before he was asked to state the correct number), nevertheless there was evidence of greater learning under the Fading procedure than under the Full-Delayed procedure: Whilst the participant, upon questioning, was able to give the correct answer on only 13% of the probe trials under the latter procedure, the corresponding figure for the Fading procedure was 38%.

Again, the participant's responses on the teaching trials are of some interest. He gave the correct response to the faded prompt on 69% of occasions, the incorrect response on 25%, and no response on 6%. Instructions to recall elicited the correct response on 0% of occasions, the incorrect response on 6%, and no response on 94%. Under the Full-Delayed procedure, the participant made no response on 100% of occasions.

The participant's behaviour on the teaching trials was of interest for another reason. During the Full-Delayed and Instructions procedures (though, interestingly, not during the Fading procedure) he occasionally engaged in 'disruptive' behaviours which prevented an appropriate response, such as dropping the cards on the floor and getting out of his seat. Generally, he appeared to find these trials somewhat upsetting. This is of particular interest because, as will be apparent from the data given in the previous paragraph, this disruptive behaviour was rarely elicited by errors (since they rarely occurred). Rather, it occurred when the participant was waiting for the full prompt to be given. Perhaps he was upset by this because it presented him with evidence of
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FIGURE 8.7: RESULTS OF STUDY II

<table>
<thead>
<tr>
<th>CBQ</th>
<th>KING</th>
<th>CAQ</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBQ</td>
<td>CAQ</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>ACQ</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CBQ</th>
<th>JACK</th>
<th>CAQ</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBQ</td>
<td>CAQ</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>QUEEN</td>
<td>CAQ</td>
<td>I</td>
<td></td>
</tr>
</tbody>
</table>

KEY: 0-0 Pre-teaching trial  CBQ Correct before question
0-0 Post-teaching trial CAQ Correct after question
F Full Immediate  I Incorrect
F Fading
I Instructions
FD Full Delayed

SESSIONS

1 2 3 4 5 6 7 8 9 10
his own lack of ability (p.158). This suggests that, for some people at least, disruptive behaviour which interferes with learning may be elicited not only by errors (p.185), but also by procedurally-enforced delays in receiving the prompt (p.158, p.173). This is clearly of relevance in considering the circumstantial determinants of the effects and countereffects of delaying the prompt (p.173).

8.3.2: Study 12

Method

Two people took part in Study 12. The first was a 41 year old man who obtained an age equivalent score on the BPVS of 3 years 5 months. He also took part in Studies 6 and 7. The second was a 37 year old man who obtained an age equivalent on the BPVS of 3 years 3 months.

The experimental design of the study was similar to that used in Study 5 (p.239). Both participants were taught to make an egg-mayonnaise sandwich, a task which involved boiling an egg and preparing a sandwich mix. This was analysed into 18 steps which, for the purposes of the experimental design, were divided into two blocks, each of 9 steps. For the first two trials, both participants were taught all the steps using a Delay procedure. On the third trial, the Instructions procedure was introduced for the steps of Block A for the first participant, and for the steps of Block B for the second participant. The other steps continued to be taught using the Delay procedure. It was intended to introduce the Instructions procedure for these other steps on the sixth trial, but in the event this did not prove possible because the learners had already nearly achieved independent performance of the task by that stage. There was one trial per session and there was typically one session per week.

Under the Delay procedure, the prompt was given after an incorrect response or, in the event of no response, after 5 seconds. The interval began immediately following the feedback for the previous step, or in the case of turning off the cooker, after the timer had begun to sound. Under the Instructions procedure, instructions to recall ("Try to remember what you do next.") were given after an incorrect response or
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after 5 seconds. In the event that the participant made an incorrect response or made no response in the following 5 seconds, the prompt was given. The same prompts were used for both participants and in both conditions. They consisted of a full verbal prompt in conjunction with a pointing prompt to the object that needed to be manipulated. The participant was judged to have completed a step unassisted if the correct response was emitted within 5 seconds and before an incorrect response had been made.

Results

The results are shown in Figure 8.8. They offer no support for the hypothesis. There was no sign of any relative improvement in performance following introduction of the instructions. The participants acquired the tasks too quickly for any effect to appear.

8.3.3: Discussion

Neither study provided any evidence to support the hypothesis that instructions to recall can facilitate acquisition. From the perspective of the analysis in Chapter 7, this result is not unexpected. We noted there (p.237) that such instructions might be expected to have an effect only if the learner would not otherwise have attempted recall, and if their attempts are likely to have some success. In respect of the card game used in Study 11, we noted earlier (p.262) that the difficulty of the task for the participants was such that some informational assistance (i.e. information about the nature of the required response) was probably necessary if recall was to occur. Instructions to recall may therefore have been ineffective in Study 11 because the participants attempts to recall were likely to be unsuccessful. In Study 12 an easier task was employed in an attempt to avoid this problem. However, this task, too, proved unsuitable in that both participants were highly motivated by it, and highly motivated to achieve independent performance on it. As a result, it seems likely that they attempted to recall the relevant information even in the absence of any instructions to recall. So again an effect would not be predicted.
FIGURE 8.8: RESULTS OF STUDY 12

Graph shows the number of steps for which no prompt was required.

Graph aggregates results: Top half combines results on Block A for the first participant (BA/P1) and Block B for the second (BB/P2); bottom half combines Block B for the first and Block A for the second.
Given these considerations, the question may be raised whether there are any circumstances in which the instructions would have an effect. In this context it is worth recalling the observation made by Striefel and Owens (1980) that, when prompt delay is used, some individuals always wait for the prompt to be given. We suggested that this might be due, in part, to a lack of self-confidence and an over-dependancy on external assistance (p.175). Instructions to recall may have some effect for these individuals. Indeed, the participant in Study 11 always waited for the prompt to be delivered under the Full-Delayed procedure. The instructions do seem to have encouraged him to attempt to recall the required response on at least some occasions (6%). Had his unassisted attempts at recall stood some chance of being effective, then he might have benefited from the instructions.

8.4: STRUCTURING DEVICES

In Chapter 7, it was suggested that the recall of several items of information may be facilitated by linking each part of the information to part of a mnemonic device which is more readily recalled because it is an abstraction (and therefore less has to be recalled), because it has already been learnt on previous occasions, and/or because it has a strong internal structure (such that each part strongly cues the recall of other parts) (p.213). It was further suggested that devices with a strong internal structure may be of particular value when it is important to recall the information in a precise order (p.215). In the case that the device is verbally encoded, the internal structure can be supplied by such features as meaning, grammar, rhythm, rhyme and musical intonation (p.215, p.234). Verbal encoding may also permit complex perceptual or motor items to be encoded in 'shorthand', which, being an abstraction, is easier to recall (p.219, p.234).

Such devices may be particularly useful in teaching chained perceptuo-motor tasks (p.232). Such tasks typically require information to be recalled in a precise order, and they may involve items of information whose encoding in perceptual or motor terms would be complex. Studies 13 and 14 investigated the effectiveness of structuring devices in teaching these tasks. The devices used in the studies encoded the relevant information in a verbal and abstract form, and had a strong
8.4.1: Study 13

Two people took part in Study 13. The first was a 41 year old man who obtained an age equivalent score on the BPVS of 3 years 5 months. He had also taken part in Studies 6, 7 and 12. The second was a 35 year old man who obtained an age equivalent score on the BPVS of 4 years.

The task taught was to tie a knot in a neck-tie. A pre-study assessment indicated that both participants were able to tighten the tie about the neck in an appropriate manner. Also before the study, both participants were taught how to position the tie correctly on the neck prior to any attempt to knot it. The remaining parts of the task were analysed into five steps as follows:

1. Wrap the fat end around the thin end.
2. Bring the fat end through the loop that the tie makes around the neck, from the front to the back.
3. Wrap the fat end around the thin end again.
4. Bring the fat end through the loop from the back to the front.
5. Push the fat end down through the knot.

These descriptions are identical to the full verbal instructions used in the study.

For the first two sessions, both participants were taught all five steps using a standard prompting strategy in which a combination of full verbal instructions and modelling prompts was given immediately, with physical guidance being given in the event of an error. For the next three sessions, the learner was given a full verbal prompt after an error or 5 seconds, and then, in the case of an error or no response within 5 seconds, a model and, if necessary, physical guidance. At the end of the fifth session, the verbal mnemonic was taught to the participants. In the sixth session, the experimental teaching procedure was used to teach the first two steps to the first participant, and the last three steps to the second participant. The standard procedure continued to be applied in teaching the other steps. In the ninth session the experimental procedure was applied to these other steps. Each session consisted of three teaching trials. There was usually one session each week.
FIGURE 8.9: RESULTS OF STUDY 13

Graph shows the number of steps for which no prompt was required. Each point represents the sum of such steps for the three trials in each session.
The verbal mnemonic took the form, "Round and through, round and through and through", each preposition corresponding to one of the five steps. At the end of the fifth session, the teacher modelled the use of this mnemonic in knotting a tie. This was done three times. The participant was then required to repeat the mnemonic from memory. Recall was cued, if necessary, by giving the initial sound of the word. This continued until the participant repeated the mnemonic without assistance. The experimental teaching strategy was identical to the standard procedure with the exception that, instead of the full verbal instruction, the teacher recited the mnemonic up to, and with an emphasis on, the preposition corresponding to the step for which the prompt was needed. For example, for the second step, instead of the full verbal prompt ("Put the fat end through the hole."), the teacher said "Round and through". During sessions 6 to 8, the experimental procedure was applied to only some of the steps. In this case, only the corresponding part of the mnemonic was recited.

Results

The results are shown in Figure 8.9. The figure shows, for each session, the total number of unassisted correct responses for all three teaching trials. It does not show any details for the first three sessions because the learner was not given the opportunity to make an unassisted response during these sessions. In Table 8.3 the results of summing the number of steps completed independently by the two participants are shown. The number achieved by the first participant on steps 1-2 have been added to the number achieved by the second participant on steps 3-5; and the number achieved by the first participant on steps 3-5 have been added to the number achieved by the second participant on steps 1-2. The results, particularly in their aggregated form, do suggest an improvement in performance associated with the introduction of the experimental procedure.

The size of the effect in the case of the first participant may have been masked. Both participants began to recite the mnemonic as they were completing the task. However, the first participant began reciting it for steps 3, 4 and 5 even before the experimental procedure had been introduced for those steps (i.e. before session 9). No doubt he was
assisted in this by the fact that the two parts of the mnemonic were very similar ("Round and through" for steps 1 and 2; "Round and through and through" for steps 3, 4 and 5), and by the fact that he had been taught the whole mnemonic at the end of session 6.

**TABLE 8.3: RESULTS OF STUDY 13**

<table>
<thead>
<tr>
<th>Trials</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1-2/P1 + S3-5/P2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>10</td>
<td>14</td>
<td>15</td>
<td>14</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>S3-5/P1 + S1-2/P2</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>9</td>
<td>10</td>
<td>13</td>
<td>15</td>
<td>14</td>
</tr>
</tbody>
</table>

[Table shows the results of adding the scores (i.e. number of steps completed without assistance) of the first participant on steps 1-2 to the scores of the second participant on steps 3-5 (top line), and the scores of the first on steps 3-5 to the scores of the second on steps 1-2 (bottom line). Numbers to the left of the broken line represent scores under the control condition, numbers to the right scores under the experimental condition.]

**8.4.2: Study 14**

**Method**

Two people took part in Study 14. The first was a 42 year old woman who obtained an age equivalent score on the BPVS of 3 years 4 months. She had also taken part in Studies 6 and 10. The second was a 50 year old woman who obtained an age equivalent score of 3 years 9 months.

The task taught was knitting. For the purposes of teaching, this was analysed as follows:
1. Push needle in right hand (right needle) up through the top stitch on the left needle.
2. Wrap loose wool around right needle.
3. Pull right needle back between top and bottom part of the top stitch.
4. Push right needle forward over the top stitch.
5. Push right needle along left needle so that top stitch comes off left needle.

Again, these descriptions roughly preserve the form of the full verbal instructions that were used in the study.

The experimental design and prompting procedures were similar to those used in Study 13. For the first 6 sessions for the first participant and for the first 4 sessions for the second participant, all five steps were taught using a procedure in which a combination of full verbal instructions and modelling prompts were given immediately, with physical guidance being given in the case of an error. For the next 3 sessions, the learner was given the full verbal instruction after an error or 5 seconds, and then, in the case of an error or no response, modelling and physical guidance. At the end of these 3 sessions, the verbal mnemonic was taught to the participants. This was done in the same way the mnemonic was taught in Study 13 with the exception that each participant was taught only that part of the mnemonic corresponding to the steps for which the experimental procedure was introduced in the subsequent session. On the subsequent session, the experimental procedure was introduced for steps 1 and 2 for the first participant, and for steps 3, 4 and 5 for the second participant. The standard procedure continued to be applied in teaching the other steps. After another three sessions, the experimental procedure was applied in teaching these other steps. Each session consisted of knitting 20 stitches. The sessions typically took place once per week.

The verbal mnemonic took the form, "Through and round, back, forward and off", each preposition corresponding to one of the five steps. The experimental procedure was the same as in Study 13. That is, instead of the full verbal prompt, the teacher recited the mnemonic up to, and with emphasis on, the relevant preposition. Before the mnemonic was introduced for all the steps, only that part of the mnemonic that the participant had learnt was recited.
FIGURE 8.10: RESULTS OF STUDY 14

Graph shows the number of steps for which no prompt was required. Each point represents the sum of such steps for the 20 trials in each session.
The results are shown in Figure 8.10. The figure shows, for each session, the total number of unassisted correct responses for all 20 stitches. It does not show any details for the initial sessions because the learner was not given the opportunity to make an unassisted response during them. In Table 8.4 the results of summing the number of steps completed independently by the two participants are shown. The number achieved by the first participant on steps 1-2 have been added to the number achieved by the second participant on steps 3-5; and the number achieved by the first participant on steps 3-5 have been added to the the number achieved by the second participant on steps 1-2. The results, particularly in their aggregated form, do suggest an improvement in performance associated with the introduction of the experimental procedure. Again, too, both participants began spontaneously to recite the mnemonic as they were carrying out the task.

TABLE 8.4: RESULTS OF STUDY 14

<table>
<thead>
<tr>
<th>Trials</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
<th>(11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1-2/P1 + S3-5/P2</td>
<td>10</td>
<td>19</td>
<td>20</td>
<td>55</td>
<td>74</td>
<td>88</td>
<td>91</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>S3-5/P1 + S1-2/P2</td>
<td>19</td>
<td>22</td>
<td>21</td>
<td>39</td>
<td>53</td>
<td>50</td>
<td>69</td>
<td>88</td>
<td>92</td>
<td>99</td>
<td>95</td>
</tr>
</tbody>
</table>

[Table shows the results of adding the scores (i.e. number of steps completed without assistance) of the first participant on steps 1-2 to the scores of the second participant on steps 3-5 (top line), and the scores of the first on steps 3-5 to the scores of the second on steps 1-2 (bottom line). Numbers to the left of the broken line represent scores under the control condition, numbers to the right scores under the experimental condition. Trial (1) refers to the first trial on which the participant was permitted to make an independent response.]
8.4.3: Discussion

The results of Studies 13 and 14 were in the expected direction. However, before accepting them as confirmation of the effectiveness of the mnemonic procedure, there is a potential difficulty in their interpretation that needs to be considered. It could be suggested that the mnemonic prompts were effective, not because they ensured that the learner used the mnemonic to recall the steps, but because, since the single preposition provided the participant with less information than the full verbal prompt, they served to fade the prompt. However, this interpretation of the results seems less attractive as a complete explanation of the effectiveness of the procedure, given that all four participants spontaneously recited the mnemonic as they were performing the task.
CHAPTER 9: SUMMARY AND DIRECTIONS FOR FUTURE RESEARCH

9.1: SUMMARY

The thesis reviewed the existing research on prompt types and procedures. Several inadequacies and omissions were revealed. Many traditional types and procedures lack any adequate theoretical rationale (e.g. p.149, p.167) or empirical validation (e.g. p.45, p. 154, p.169, p.204). There is also a lack of empirical and theoretical work concerning the formal and circumstantial factors which may determine their effect; and their combined and comparative effects.

We have also attempted to remedy some of the theoretical defects, and thereby to suggest ways in which established prompting practices may be more effectively applied and to suggest some relatively novel practices. Some of this work was done within a behavioural approach. For example, we used an analogy with response shaping to illuminate, and thereby guide, the use of stimulus prompts in teaching the response component (p.64). We also used the approach to provide an account of the formal determinants of prompt types (p.25, p.52) and of the different methods of fading (p.155); and to provide an argument in favour of combining prompts (p.73) and a rationale for the fading of stimulus prompts (p.145).

The theoretical issues were also discussed from a cognitive perspective. For this purpose a basic cognitive account of learning was described. This was then used to provide theoretical rationales for various established practices whose justification is otherwise absent or incomplete - for example, fading (p.223), delay (p.225), the avoidance of errors (p.226) and partial task training (p.203, p.227). The account also proved useful in suggesting or validating some relatively novel practices. Thus, with reference to prompt types, we used it to provide an account of how stimulus prompts might be used to facilitate the acquisition of the response component (either by increasing the attentional value of its discriminating features (p.96) or by enabling a less sophisticated approximation (p.98)); a rationale for explicitly
teaching about the specific and general goals of the response (p.103); and an account of how prompts can be used to enhance generalization (p.104). With reference to procedures, the cognitive account was used to suggest some novel ways of fading the prompt (p.234) or otherwise reducing its control (p.236); and to suggest various ways of manipulating the initial encoding of the relevant information in such a way as to enhance acquisition (p.229).

The empirical investigations that were conducted confirmed the potential value of some of these novel practices, including the use of structuring mnemonic devices (Studies 13 and 14), the use of a novel variant of fading (Studies 7, 8, 9 and 11), and the application of stimulus prompts in teaching response components (Studies 1 and 2). The investigations also provided evidence for the effectiveness of more established practices which have hitherto lacked controlled experimental support. These included the fading of response prompts (Studies 5, 6, 7, 8, 9 and 11) and the use of stimulus prompts to teach stimulus components in contexts other than choice discrimination (Studies 1 and 2). The studies also tested the effectiveness of delaying the prompt (Studies 9 and 10) and instructions to recall (Studies 11 and 12), but failed to find evidence of this. This suggested the importance of considering the circumstantial determinants of effectiveness, rather than a rejection of the procedures (p.261, p.269). Evidence was also provided that, in some circumstances, full physical guidance can be less effective than alternative prompt forms (Studies 3 and 4), and delaying the prompt can be less effective than fading it (Studies 7 and 9).

9.2: DIRECTIONS FOR FUTURE RESEARCH

In Chapter 1, we established some general criteria for the purposes of evaluating the existing research. These criteria can also provide a basis for making suggestions about the direction for future research. They were discussed in terms of what questions the research should address, the role of theory, and methodological issues.

Asking the Right Questions

It was suggested that research needs to investigate the effects of
prompting components not only on the acquisition of the targeted response, but also on the generalization and maintenance of that response, on teaching resources, and on other aspects of the learner's functioning (p.3). For each component, we also need to consider how formal and circumstantial factors influence its effects; and, relative to other components, its combined and comparative effects (p.3).

Some of these questions appear to have been particularly neglected in existing research, and accordingly merit more attention in future research. The neglect of circumstantial factors has been noted by others (Billingsley & Romer, 1983; Wolery & Gast, 1984; Schoen, 1986; Handen & Zane, 1987; Doyle et al., 1988). Despite their importance (see, for example, p.42, p.165, p.187, p.225), reference to these factors is typically brief, and the theoretical explanation of why they may be important is absent or inadequate (e.g. p.40, p.58). Direct empirical investigations are rare. There are only a few which have investigated their influence on the effectiveness of prompt types (p.43, p.59), and it is difficult to find any such studies involving procedures. The significance of circumstantial factors is also routinely overlooked in studies comparing the effects of different components. In consequence, oversimplified claims have been made to the effect that one type or procedure is superior to another. In reality, it is likely that a component is superior in some circumstances, but inferior in others (p.57, p.160, p.178). For example, on the basis of a few studies, it has been claimed that delaying the prompt is superior to fading it (p.181). However, Studies 7 and 9 (p.256) demonstrated that, given the right circumstances, fading can prove more effective.

Further investigation also needs to be directed towards the combined and comparative effects of components. The lack of comparative studies has been noted elsewhere (Billingsley & Romer, 1983; Wolery & Gast, 1984; Schoen, 1986; Handen & Zane, 1987; Doyle et al., 1988), though an exception is provided by the recent batch of studies comparing fading and delay (p.180). Studies of the effects of combining components are even more difficult to find (Schoen, 1986). A search of the literature revealed only five such studies, all of which concerned the effects of combining stimulus and response prompts and none of which were directly concerned with the effects of combining prompts (p.76). Yet information
about the combined and comparative effects is important. Combinations may be more effective at conveying knowledge of the task requirements to the learner (p.73, p.129) and, in the case of those with more severe learning disabilities, may even be essential to this end (p.130). The value of comparative studies is based on the fact that it may not always be possible or desirable to combine components, and so the user of prompting technology may need to choose between them (p.3).

Another neglected topic is the issue of whether the components differ in their effects on the generalization and maintenance of the acquired response, and on other aspects of the learner's functioning. We have had occasion to suggest that there may be important differences in these respects. For example, we have argued that the form of the prompt can be manipulated in order to enhance generalization - namely, by giving information about the appropriate general classification of the items (p.105), and by giving information about the specific (p.85, p.103) and general (p.233) goals of the response. Another example is provided by the suggestion that passivity and other negative consequences may result from an excessive use of full physical guidance (p.78) or from excessive overprompting (p.156).

Another general guideline offered in Chapter 1 was that, for reasons of efficiency, the research programme should investigate the effects of the components of strategies (i.e. particular types or procedural variables), rather than the effects of the composite strategies themselves (p.3). Because there are many more strategies than components, a focus on the effects of strategies would require a much more extensive programme of research in order to supply the user of the technology with sufficient information to select the optimum strategy in all circumstances. However, existing research is often strategy-based and illustrates the difficulties associated with this approach. For example, in discussing studies which have compared fading and delay, we noted that the concern of the investigators appears to have been to compare, not two procedural components, but two strategies as they are typically applied (p.183). In consequence, the effects of the two components were not experimentally isolated, but were confounded by other differences between the two strategies (e.g. differences in the type of prompt used, and in whether pre- or post-response prompting was used),
and, in the case of those studies which investigated the increasing assistance variation of fading, by the inclusion of a delay component in the fading strategy. Because of this confounding, it is not clear what made the delay strategies more efficient. This, in turn, restricts the number of conclusions we can draw from the study, relative to the number that could be drawn from an unconfounded component-based study. For example, whereas from the latter we could typically infer that, other things being equal, any strategy containing the superior component would be superior, in essentially similar circumstances, to any strategy containing the inferior component; from the strategy-based study we could only infer that the particular combination of components that constituted the superior strategy in the study would be superior, in essentially similar circumstances, to the particular combination that constituted the inferior strategy. In other words, the strategy-based study permits inferences only about the particular combination of components used in the study; but the component-based study also permits inferences about other strategies containing the component whose effects were investigated. Because of the inferential superiority of a components-based approach, it will require a much smaller number of studies in order to determine what strategy will be the most effective in any given set of circumstances.

The existing research also suggests another disadvantage of the strategy-based approach. The disadvantage is a psychological, rather than a logical, one, and consists in a lack of flexibility and imagination in devising prompting strategies. In selecting a prompting strategy for use in research or practice, there seems to be a tendency to make the choice from the restricted set of established strategies, rather than combining different components in relatively novel ways in order to meet the particular requirements of the circumstances in hand. Clearly, the latter approach may often provide a strategy which is novel, but more effective than any of the established strategies. An example can serve to illustrate the tendency and its associated disadvantage. In Chapter 6 (p.167), we discussed the recommendation that the decreasing assistance procedure should be used for those with a more severe learning disability, and the increasing assistance procedure for those with a less severe disability (Wolery & Gast, 1984; Schoen, 1986). The rationale for this was that the verbal prompts used in the latter would not be
Conclusion

functional for the less able, and the physical prompts used in the former would provide too much assistance for the more able. However, this overlooks the fact, obvious from a components-based perspective, that all the prompts used in a decreasing assistance procedure can be verbal, and all the prompts used in an increasing assistance procedure can be physical. Indeed, in some circumstances, one of these novel strategies might be more effective than either of the traditional strategies. For example, in teaching the less able, an increasing assistance procedure in combination with varying degrees of physical guidance might prove more effective than either a strategy which includes an overprompting decreasing assistance procedure (p. 156), or a strategy which includes non-functional gestural and verbal prompts (p. 163).

Methodology

Future research also needs to improve its methodology (p. 11). A striking feature of existing research is that, with the exception of the use of stimulus prompts in teaching choice discriminations (p. 17), there is an almost complete lack of experimentally controlled evidence concerning the effectiveness of the various prompt types and procedures in use. It is common to cite, as evidence of their effectiveness, studies in which the response was successfully acquired when some teaching strategy containing the component was applied (e.g., Billingsley & Romer, 1983; Wolery & Gast, 1984; Schoen, 1986; Handen & Zane, 1987; Doyle et al., 1988). However, as we made clear in Chapter 1 (p. 11), such uncontrolled studies do not provide satisfactory evidence of effectiveness. In the absence of a control condition, we cannot eliminate the possibility that acquisition was due to some other component in the strategy, or that it would have occurred even in the absence of any prompts. Indeed, in one of the few controlled studies of the effects of behavioural teaching, Matson et al. (1980) found that direct behavioural teaching of self-care skills was ineffective relative to a no-teaching condition. The methodological inadequacies of the evidence which purports to validate behavioural teaching methods has been noted by others (Gardner, 1969; Roos & Oliver, 1969; Baumeister, 1969; Navas & Braun, 1970; Nelson et al., 1970; Clements, 1987).
A Role for Theory

In Chapter 1, we argued that research should be guided by theory, as well as the empirical evidence, because this is the only efficient way of discovering the relevant variables (p.5), and because, in the absence of empirical evidence, theories are useful to the user of the technology in selecting a strategy for a particular set of circumstances (p.6). We should concentrate the empirical investigation on those variables considered likely to have an effect. However, the existing research is characterized by a lack of theoretical guidance. Evidence of this abounds. For example, Schuster et al. (1988) investigated whether delaying the prompt will be effective in teaching chained responses. The reason offered for conducting the research was the observation that the delay procedure had been extensively applied to the teaching of discrete responses, but had rarely been applied to the teaching of chained responses, and even then only progressive delay had been used. They gave no theoretical reason for expecting that there would be an interaction between the chained-vs-progressive and the constant-vs-progressive variables. Similarly, Demchak (1989) gives, as her reason for comparing the graduated guidance and increasing assistance strategies, simply the fact that comparative studies are rare, and she offers no theoretical reason for expecting one to be superior to the other.

Others, too, have noted that the existing research lacks guidance and direction in its attempts to determine which variables have an influence on the effectiveness of prompting, and, in consequence, seems to be making little progress (Billingsley & Romer, 1983; Doyle et al., 1988). Along with others (e.g. Wolery & Gast, 1984; Schoen, 1986), they have sought to remedy this problem by offering lists of possible variables for future investigation. However, their solutions do not reach to the heart of the problem. Most of the variables on these lists are suggested without any theoretical rationale being offered for their inclusion. For example, Doyle et al. (1988) recommend research into how the effectiveness of the increasing assistance procedure varies with the age of the learner, without suggesting any reason why it should make a difference; and Billingsley and Romer (1983) recommend research into whether the iconicity of the prompts (i.e. their physical resemblance to the required response) influences acquisition, without giving any reasons why it
might. The source of the directionless nature of existing research is a lack of theory, not a lack of lists of variables.

We also argued that, in seeking theoretical guidance, it makes sense to explore as many areas of basic and applied psychology as may be relevant, particularly those with a bearing on the psychology of learning (p.6). However, the existing research on prompting is almost exclusively behavioural in its inspiration. Other relevant areas, such as personality theory and cognitive psychology have had little, if any, influence (p.15). The use that we have been able to make of the cognitive account in terms of developing new practices and refinements to traditional practices (see p.278) suggests that cognitive psychology, in particular, has the potential to make a valuable contribution to future research.

9.3: CONCLUSION

We began this thesis with the observation that the established teaching technology for people with learning disabilities fails on a significant number of occasions (p.1). In itself, this does not mean that the technology can be improved. It may be that the failures all result from an attempt to teach the individuals things that they simply cannot learn (Bailey, 1981; Ellis et al., 1982), or from an inadequate application of the technology. However, the current investigation has suggested otherwise. At least in respect of prompting, there is room for substantial improvement. This, in turn, indicates the need for further research. It also suggests that we should avoid, on the one hand, the complacent assumption that we know all there is to know about teaching people with learning disabilities (p.1), and, on the other, the pessimistic assumption that those with profound learning disabilities cannot be taught any useful skills (p.2).
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