MEDIATION AND INHIBITION DEFICITS

IN

RETARDATE DISCRIMINATION LEARNING

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Abstract

Investigations into the extent and nature of basic learning deficiencies in mentally retarded children have not yielded consistent results. Although it has often been found that mentally retarded children perform more poorly than normals of similar MA in discrimination learning, a number of alternative hypotheses have been proposed to account for the instances of retardate inferiority. Included among these hypotheses are impaired verbal mediation, defective attention to certain stimulus attributes, deficient inhibitory processes, and inadequate motivation. The lack of consensus which has arisen from the previous research may be due largely to methodological inadequacies which have rendered the findings of many studies ambiguous.

A repeated measures design was used to study discrimination learning in moderately retarded and normal children of similar MA. Procedures were incorporated which overcame the weaknesses present in many previous studies. The main purpose was to investigate the above hypotheses concerning the nature of gross

learning deficits in the retarded. Certain more general hypotheses about the processes involved in discrimination learning were also examined.

Two experiments tested nine hypotheses derived from attention and verbal mediation theories of discrimination learning. The ITPA was used to assess the level of verbal development of the _S_s. In general, the results supported attention rather than verbal mediation theories. The retardates, even though markedly inferior in verbal development, were no less able than the normals to exhibit mediational transfer in discrimination shifts. Verbal development was not related in a clear-cut way to mediational capacity in the discrimination tasks. The only result clearly favouring verbal mediation theory was evidence suggesting that the _S_s were in a transitional stage of mediational development.

Four experiments were concerned with inhibition deficits in retardate discrimination learning. The retardates were not found to be deficient relative to the normals in learning to withhold responses to the negative cue, regardless of whether inhibitory tendencies were rewarded or not. The retarded _S_s exhibited a

marked deficit in tasks involving the suppression of a previously established habit. A comparison of extinction performance with reversal learning suggested that this deficit had to do with the flexibility rather than the inhibition of established habits. The deficit did not result from inadequate motivation in the retarded _S_s.

The outstanding implication of the research for remedial education was the pervasive indication of gross inflexibility in retardate performance. It was concluded that urgent attention should be given to devising programs for increasing the flexibility of retardate behaviour.

Statement on Sources

This thesis describes original work undertaken in the Faculty of Education. To the best of my knowledge and belief, any work not my own has been acknowledged in the text. The main original contributions are presented in Chapters 2, 4, 5, and 6.

I hereby declare that no part of this original work has been submitted for any other degree.

Signed_

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Table of Contents

List of Tables

Page

List of Figures

Introduction

By definition, mentally retarded children are defective in learning. But in what respects are they poor learners? How defective are they in learning? Why do they exhibit learning deficits? In an effort to answer such questions, numerous experimental studies have compared the performance of retarded and normal children of similar mental age (MA) in discrimination learning.

The major reasons for adopting this strategy are as follows. An experimental discrimination learning task requires the subject to select the correct cue from among a number of alternatives over a series of trials. To be consistently successful in such a task, the subject has first to abstract the correct cue from among the alternatives, and then generalize on the basis of his abstraction to succeeding trials. As the processes of abstraction and generalization are fundamental to all problem solving, experimental discrimination learning represents a prototype of cognitive behaviour. It is therefore important to discover how retarded children compare with normals in discrimination learning.

Comparisons between retarded children and their normal MA peers are directed towards answering the question: how defective are retardates? Clearly if retardates perform more poorly than their normal MA peers on certain tasks, then a gross deficit is indicated with respect to these tasks. The next step would be to determine what processes were responsible for the retardates gross deficits. This information would have immediate significance for curriculum development purposes.

At present there is no general consensus of opinion about either the existence or nature of gross discrimination learning deficits in the retarded. On the one hand, some studies have simply not found differences between retardates and normals of similar MA. While, on the other hand, many studies have reported consistent differences, there is disagreement about the interpretation of the findings--i.e., about why the retardates showed a gross deficit. Some of the hypotheses that have been proposed to account for instances of poorer discrimination learning by retardates than their normal MA peers are: impairment in the use of verbal mediators (Luria, 1961. 1963); defective attention to certain stimulus attributes (Zeaman & House, 1963); defective inhibitory processes (Denny, 1964; Luria, 1963); and inadequate or inappropriate motivation (Zigler, 1966). While these hypotheses lead to conflicting predictions about the performance of mental retardates in discrimination learning, they all imply that under certain conditions retardates will perform more poorly than normals of similar MA.

Many reasons can be suggested why our present knowledge about retardate-normal differences in discrimination learning is inconclusive. The methodology employed in many studies has not been adequate to allow unambiguous interpretation of results (Ross, 1966; Slamecka, 1968). Procedures, subject characteristics, and types of tasks have differed widely between studies. The majority of projects have taken the form of single experiments designed to produce data consistent with the researcher's own theoretical bias. A more heuristic procedure would be to use the same Ss in a series of experiments, designed so that predictions from differing theoretical viewpoints would be measured independently. In this way the relative contributions of each could be assessed more reliably. (A similar approach was advocated by Miller, Hale & Stevenson, 1968.)

The present research used a repeated measures design to study discrimination learning in moderately retarded and normal children of similar MA. The main purpose was to investigate issues pertaining to the above-cited hypotheses concerning the nature of gross learning deficits in the retarded. In addition, certain more general hypotheses about the processes involved in discrimination learning were also examined.

Chapters 1 and 2 are concerned with mediation processes in retardate and normal discrimination learning. The first chapter reviews previous research, while the second chapter reports two experiments which tested a series of hypotheses derived from mediational theories of human discrimination learning. Particular attention is given to the relationship between verbal development and mediation.

Chapters 3 and 4 deal with inhibition deficits in retardate discrimination learning. Previous research is considered in Chapter 3, and four experiments comparing the retarded and normal groups in various aspects of inhibition are reported in Chapter 4. Because of a lack of theoretical and empirical clarity in the area, a specific hypothesis testing approach was not followed in these four experiments. It was considered more appropriate to adopt the procedure of comparing the performance of the subject groups in order to determine the extent and nature of retardate deficits in the inhibition sphere.

The data analyses in Chapters 2 and 4 deal mainly with retardate-normal differences in performance. In Chapter 5 a closer examination is made of performance differences within the retarded group on a number of the experimental tasks.

A summary of the research followed by a discussion of the main findings is presented in Chapter 6, the final chapter.

Chapter 1

Mediation in Discrimination Learning: Background

Discrimination learning research employing human *Ss* is dominated by theories which postulate the operation of mediational mechanisms. One of the more influential of these formulations which has been extensively applied to the learning of mentally retarded *Ss*, is the theory of Zeaman and House (1963). This treats discrimination learning as a two-stage process in which *S* must learn to attend to the relevant stimulus dimension, before being able to learn to attach responses to the different cues on that dimension. All *Ss*, regardless of age or infirmity, are considered to learn in the same manner.

Zeaman and House found in a number of experiments that retarded children often take longer to learn two-choice simultaneous discriminations than do normal children of the same MA. The kinds of problems in which retardates exhibit this gross learning deficit are those in which the stimuli to be discriminated differ in colour or form. These problems are said to be difficult for retardates because they have a lower initial probability of attending to these dimensions than do normals. However, once they have observed the relevant dimension retardates easily learn to select the correct cue, and proceed as rapidly as normals to an asymptote of approximately 100% correct choices. Furthermore, when a shift is introduced following successful initial learning, all Ss carry over their previous dimensional orientation to the new problem. Both retardates and normals demonstrate positive transfer if the original dimension remains relevant in the shift (an intra-dimensional shift), and negative transfer if the original dimension is made irrelevant in the shift (an extra-dimensional shift). Thus it is only in the first stage of the discrimination learning process--attention to the relevant stimulus dimension--that the Zeaman and House theory predicts retardate-normal differences.

The Kendlers (Kendler & Kendler, 1962; T. S. Kendler, 1964) proposed an alternative mediational theory of discrimination learning which emphasized a developmental changes in the manner of solving such problems. In their view the performance of pre-school children (and animals) in two-choice simultaneous discriminations conforms to a single-stage model, but a two-stage process is required to account for the behaviour of older children and adults. One-stage learners (non-mediators) are said to take longer to learn a discrimination than two-stage learners (mediators), as well as exhibit zero mediational transfer in a subsequent shift problem. Two-stage learners are predicted to show positive transfer in intra-dimensional (ID) shifts and negative transfer in extra-dimensional (ED) shifts. The occurrence of mediation is attributed to the operation of covert representational responses which are thought to be either verbal or somehow activated by verbal responses.

The Kendlers have not measured directly the verbal development of mediators and non-mediators but their theory receives support from the work of Luria (1961). He found that the development of the regulatory role of the verbal system[1] reaches maturity in children of

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[1] A major segment of this report deals with the

about 5 years of age, and this is the stage at which the Kendlers believe children tend to become predominantly mediators. In fact Kendler (1964) described three stages in the development of mediational responding which she considered corresponded to the stages in the development of verbal-motor control outlined by Luria.

Although the performance of retarded children has not been studied by the Kendlers, it can be predicted from a combination of their theory with other evidence that these Ss would exhibit a deficiency in mediation relative to normal children of similar MA. The 'other

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relationship of certain aspects of verbal functioning to performance. The verbal functions of relavance are embodied in the Russian conception of second signalling system functions, which are concerned particularly with the use of 'inner language' (or covert verbal processes) as an instrument for thinking and a method of regulating behaviour. To simplify the exposition the word 'verbal' (rather than 'speech' or 'language') will be used throughout to refer to such processes, unless the work of another author is being cited.

evidence' is Luria's (1963) view that a dissociation between the verbal and motor systems is a characteristic feature of the retarded child.

Thus the Kendler and Zeaman and House theories are in accord about the behaviour of older children and adults in discrimination problems, but disagree as to whether transfer in younger normal children and retardates differs from that in older normals. (Instances of slow initial learning by young normals can easily be accommodated in the Zeaman and House position by postulating a low observing probability.) The theories are also in disagreement about the nature of the mediational process. However, they agree that the function of the mediator is to establish response control by the relevant dimension. A conceptual difference between the positions relates to how this is achieved. In the Kendler theory it is assumed that the mediating response adds cues to the external stimuli. In 'observing response' theories it is assumed that the mediating response acts as a selective mechanism which subtracts irrelevant cues from the stimulus situation.

The considerable body of literature bearing on the two theories has been examined in two recent reviews (Shepp & Turrisi, 1966; Wolff, 1967). Although there is clearly a lack of unequivocal support for certain aspects of both theories, the reviewers considered that the general trend of the evidence favoured the Zeaman and House account of discrimination learning. Wolff, for example, concluded that the principal factors operating in concept shift problems are probably attentional in nature. While verbal mechanisms may play an important part in some concept shift tasks, this occurs because of the effect that verbalization has in coercing attention to the relevant or irrelevant dimensions. He also considered that there was little support for the Kendlers' developmental hypothesis of a relationship between age, mediation, and learning speed. Shepp and Turrisi, on the other hand, concluded that the results of a number of studies appeared to support the Kendlers' position that performance differences on various shifts reflects the developmental level of the Ss. They added, however, that this conclusion may be premature, because of evidence suggesting that level of pre-shift training might be the major determinant of post-shift performance.[2] While such evidence can easily be accommodated within the Zeaman and House theory, it is incompatible with the Kendlers' developmental hypothesis.

Wolff's conclusions apropos of the specific issue of retardate-normal differences in shift performance did not consistently favour either theoretical viewpoint. An implication from the combined Kendler-Luria position is that retardates would be predominantly non-mediators. This should be manifested in poorer ID shift learning by retardates relative to normals of similar MA (excepting normals below the age of about 5 years, who would also be predominantly non-mediators). Zeaman and House, on the other hand, do not believe that non-mediators

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[2] T. S. Kendler and H. H. Kendler (1966) tested this hypothesis and found no evidence that number of trials on the initial discrimination affected the tendency to make optional reversal shifts. It is also the case that many studies have not found a straightforward relationship between overtraining on an original discrimination and subsequent shift learning (Eimas, 1969).

in the Kendler sense exist. All Ss who learn are said to mediate (acquire an attending response to the relevant dimension). Therefore retardates and normals at all ages should perform similarly in ID shifts. Wolff cited 17 comparisons of the two kinds of Ss (in every case with mean MAs of approximately 5 years or higher) on various ID shifts. Normals had been found superior in eight, retardates had been found superior in two, and no difference was reported in the remaining seven. In one study (Heal, Ross & Sanders, 1966) utilizing colour as the relevant dimension (a 'hard' dimension for retardates, according to Zeaman and House), the groups did not differ in initial learning (IL) but the normals were superior in shift learning (SL). The results of both learning stages in this experiment contradict Zeaman and House. Wolff took this to indicate that retardates may differ from normals in more ways than just the initial probability of observing the relevant dimension. He also reported, however, that most of the studies examining the performance of low IQ Ss on both ID and ED shifts had found the ID problem to be the easier. This would suggest that retardate behaviour is fully consistent with a two-stage model, as Zeaman and House have indicated.

How could such discrepant results emerge when the majority of experimenters have adopted the same general testing strategy (two-choice simultaneous discrimination learning)? In a methodological examination of human discrimination learning research, Slamecka (1968) pointed out that the shift paradigms commonly used to test mediation theories harbour possible biases which could confound the results. Lack of control over the differential effects of intermittent reinforcement, shift detection, obviousness of solution, stimulus novelty, and negative instrumental transfer, are the main sources of bias which preclude unambiguous interpretation of many experimental findings. Moreover, there does not appear to be sufficient evidence to argue that the data as a whole have a collective impact, which overrides weaknesses present in particular experiments taken in isolation.

Only one conventional discrimination learning study with human Ss (Eimas, 1966) was cited by Slamecka as utilizing a bias free method. This employed a 'total change design' in comparing the performance of children on ID and ED shifts. In this design the relevant and irrelevant stimulus dimensions from the original problem are retained in the shift, but a completely different set of cues are used in each problem. The Eimas study used normal Ss in two age categories, 5 to 6 years and 7 to 8 years, and found that age had a significant effect on IL but not SL. For both age groups the ID shift was learned significantly faster than the ED shift, and there was no Age X Shift interaction. These results were interpreted as supporting the two-stage mediational position of Zeaman and House, but not the Kendlers' theory. However, three points need to be made about this conclusion. Firstly, the finding that older Ss learn the initial problem more quickly than younger Ss is a prediction from the Kendler theory. (While Zeaman and House could easily accommodate this eventuality, they have not emphasized age effects in the way that the Kendlers have.) Secondly, it is Ss below the age of 5 years that the Kendlers particularly consider to be non-mediators (a similar view is expressed by Luria, 1961), but all of Eimas's Ss were over 5. (The mean CA of the younger group was 68.2 months.) Thirdly, Eimas had to give 56% of his younger Ss and 33% of the older Ss special training in order to reach criterion on the initial problem. The training consisted of showing the Ss the positive stimuli and informing them that these were the correct ones, and then displaying the two negative stimuli and informing S that these were the wrong ones. This seemingly innocuous procedure could have introduced a bias, by increasing the likelihood that S would acquire a dimensional response and hence behave like a mediator.[3] Tighe and Tighe (1970) demonstrated that a somewhat similar kind of perceptual pretraining facilitated children's selection of optional reversal shifts.

Other experiments employing a total change design were reported by Campione (1970), Campione, Hyman and Zeaman (1965), Cunningham (1969), Dickerson (1966), Mumbauer and Odom (1967), and Shepp and Turrisi (1969).

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[3] Eimas reported that the differential use of special training was not significantly related to shift learning. However his analysis is not relevant to the point being made here.

While the results of all these experiments tended to favour the Zeaman and House position, only the study of Mumbauer and Odom is unequivocal. Using normal pre-school Ss ranging in age from 3 to 6 years, these investigators found that both an ID shift and a reversal shift were learned in significantly less trials than an ED shift. This outcome is contrary to the Kendlers' developmental hypothesis, which predicts no overall ID-ED shift difference for pre-school Ss.

A confounding influence in the studies of Campione *et al*. and Cunningham was the introduction of 100 over-learning trials on the initial discrimination before shift learning commenced. In both experiments it was found that after overlearning, retarded Ss learned an ID shift more easily than an ED shift. But this cannot be taken as evidence that immature Ss would exhibit the same pattern in the absence of overtraining. This point is illustrated by the results of Shepp and Turrisi (1969), who manipulated three levels of over-learning (0%, 100%, and 300%, where number of trials to criterion was the denominator in the percentage ratios) before introducing the shift problems to their retarded

_S_s (mean MA 73.5 months). It was only after 300% overtraining that the superiority of ID shift learning became apparent. Under the other two overlearning conditions, the very slight ID-ED difference actually favoured the ED groups. Although the investigators did not draw this conclusion, the results imply that under zero or moderate degrees of overtraining, retardates tend to behave like non-mediators. Other studies (Ohlrich & Ross, 1966; Sanders, Ross & Heal, 1965) have indicated similar effects for retarded _S_s in the absence of overlearning.

Campione (1970) investigated optional ID and ED shift behaviour in pre-school and second-grade children (mean CAs 48.8 months and 97.4 months, respectively). It was found that the tendency for _S_s to choose ID rather than ED shifts was independent of age. This result sharply conflicts with the Kendlers' work suggesting that the probability of an _S_ executing an optional reversal shift increases with age. However, Campione gave 40% of his younger _S_s and 25% of the older group special training to enable them to reach criterion on the initial problem. In a similar fashion to Eimas (1966) the training consisted of displaying the positive and negative stimuli before S, and pointing out to him which cues were always correct and which were never correct. As discussed above, this procedure may bias S's likelihood of acquiring the relevant dimension.[4] The same artefact renders ambiguous Dickerson's (1966) finding that ID and reversal shifts were learned faster than ED shifts by normal 4-year-olds.

In opposition to the above evidence Kendler and Kendler (1969) reported that they have continued to obtain support for their theory of ontogenetic changes in mediation, using a variety of tasks, experimental procedures, Ss, and experimenters. Other recent evidence favouring the Kendlers' position was obtained by Guy (1969), who found a developmental change in the performance of children on complemental and noncomplemental rule shifts.

Let us overlook for a moment the question of

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[4] Like Eimas, Campione reported that the differential use of special training was not significantly related to any of the dependent variables; but again the analysis presented is not relevant to the point at issue.

methodological adequacy, and return to Wolff's evaluation of ID shift learning by retardates. He concluded that the weight of evidence suggested "either that retardates are not so deficient in verbal mediation as many have supposed or that the operation of verbal mediating responses is not necessarily implied by ID superiority (p. 384)." In relation to the second point, the Kendlers have made it clear that they are not irrevocably commited to the view that mediation is necessarily verbal (H. H. Kendler & T. S. Kendler, 1966; T. S. Kendler, 1964). The verbal system was suggested as a likely vehicle for mediation because it offered a plausible explanation of differences observed between the behaviour of older children and adults, on the one hand, and younger children and animals on the other. But it was recognized that mediating events could be coordinated to other systems.

Luria's view is more adamant. He said (1963, pp. 195-196), "It is known that every cognitive activity of the normal child is to a great extent mediated by speech. Every manifestation of reality is refracted through the prism of the complex system of verbal connections enabling the child to assimilate general human experience and to apply this to his perception of the encountered environment. Every action is regulated with the close cooperation of these verbal connections...." While one is probably not meant to infer from this that non-verbal mediation is impossible, it does imply that the complexity of behaviour formulated in the absence of the second signalling system is severely limited. Regarding the extent of verbal involvement in the retarded child's behaviour, Luria is equally adamant. He said (1963, p. 196), "....speech processes play a much smaller role in the organization of the activity of the mentally retarded child than that of his normal peer; his actions more easily cease to be mediated by verbal connections, escape from verbal control, and assume a spontaneous impulsive character."

Spreen (1965) concluded his review of language functions in mental retardation with a discussion of the two questions (1) Is verbal mediation a necessary and integral part of intelligent behaviour? and (2) Does the mental defective suffer from a specific verbal mediation deficiency which cannot be accounted for on the basis of MA? In dealing with the first question he referred to studies which had employed deaf and aphasic Ss as well as retardates and normals. This work suggested that "verbal control should be viewed independently from conceptual control. If adequate non-verbal tasks are devised in which verbal experience plays a negligible role, non-speaking subjects tend to perform as well as speaking subjects (Spreen, 1965, p. 359)." Of course it is unlikely that many people would disagree with this statement. It has the flavour of a tautology. But to what extent does it vitiate the views of the Kendlers and Luria? Neither of these theorists would deny that non-verbal tasks can be devised, nor that non-verbal problem solving is possible. The focus of their arguments is to underline (Luria more heavily than the Kendlers) the importance of the verbal system as an instrument of thinking and a means of regulating behaviour. A person's ability to analyze a problem and make abstractions and generalizations is considered to be greatly enhanced by the intervention of a mature verbal system. The role of verbal mechanisms in such processes was not closely examined in the kinds of experiments upon which Spreen based his opinion.

Concerning the question of a verbal mediation deficiency in retardates, Spreen considered the findings to be rather controversial. It has already been indicated that Luria regards this deficiency to be a basic feature of the retarded individual. Jensen and Rohwer (1963, 1965) advocated a similar view. But Furth and Milgram (1965) stated, "The retarded Ss' verbal deficiency should not be construed as a general verbal inability over and above their general cognitive level (p. 342)." These investigators found evidence of a verbal deficiency in retardates, but preferred to interpret it as a lack of verbal efficiency rather than as a lack of verbal ability.

A deficiency in verbal mediation is signified, according to Luria, by the fact that retardates are usually unable to give an adequate account of their behaviour in discrimination tasks. The inability of these Ss to verbalize their learning has been confirmed in other studies (Klugh & Janssen, 1966; O'Connor &

Hermelin, 1963; Stephens, 1966; Stevenson & Iscoe, 1955). In the Klugh and Janssen experiment though, the ability to verbalize was found to be affected by a procedural variation. In a simultaneous discrimination retardates were much less likely to give a correct verbal account of their learning than were normals, but in a successive discrimination the groups differed only slightly in this respect. To account for this result within Luria's framework would be very difficult (particularly as he used mainly successive presentation), although it could possibly be attributed to differences in the components of simultaneous and successive problems (Heal, Dickerson & Mankinen, 1968). However, the validity of inferring covert processes occuring during an experiment from overt verbal responses in post-experimental reports has been seriously questioned (Farber, 1963; Wolff, 1967), and evidence obtained in this way is not compelling.

In order to resolve the verbal mediation deficiency issue, what is required (in addition to a bias free test of mediation) is a measure of verbal ability that assesses the kinds of processes upon which mediation is thought to depend. The instrument with most potential for this purpose is the Illinois Test of Psycholinguistic Abilities (ITPA) (McCarthy & Kirk, 1961[5]). In this test linguistic abilities are specified in terms of three dimensions: levels of organization, psycholinguistic processes, and channels of communication. Two levels of organization are considered; the representational level, which is concerned with activities involving the meaning or significance of symbols, and the automatic-sequential level, which deals with non-meaningful retention of material. The three psycholinguistic processes measured are decoding (the interpretation of stimuli), encoding (the expression of intentions or ideas), and association (the ability to relate, organize, and manipulate symbols in a meaningful way). Behaviour is examined along two communication channels: auditory-vocal and visual-motor.

The ITPA representational level model (McCarthy & Kirk, 1961) is conceptually similar to the concepts of

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[5] The 1961 edition of the ITPA was an experimental edition. A revised edition has since been published (Kirk, McCarthy & Kirk, 1968).

mediation used by the Kendlers and Luria. Kendler (1964) described mediation as a chain with at least three elements: the evocation of a representational response by the external stimulus, the production of a distinctive cue by the representational response, and the elicitation of an overt response by the response-produced cue. These three events closely correspond, respectively, to the psycholinguistic processes of decoding, association, and encoding. If translated into verbal behaviour, the events in the mediation sequence and the psycholinguistic processes would involve mechanisms like: verbal analysis of the stimulus, formulating in verbal terms the rule for behaviour (i.e., the response to be made in the presence of a particular stimulus), and using the rule to guide behaviour. These three mechanisms are allocated a central place in Luria's theory concerning the role of the verbal system in behaviour. In a partial replication of some of Luria's work, Joynt and Cambourne (1966) found that the development of the verbal regulation of behaviour in Australian children correlated more highly with ITPA total language age (LA) than with CA (average correlations computed by the present author were 0.84 and 0.75, respectively). Unfortunately the investigators did not report correlations between the separate ITPA subtests and the development of verbal-motor coordination.

Correspondence between the psycholinguistic model and the theories of the Kendlers and Luria suggests that a deficiency in verbal mediation should be manifested by poor scores on the representational level tests of the ITPA. Furthermore, from an examination of the ITPA profile, it should be possible to determine whether all, or only some, of the elements in the mediation chain were defective. Kendler (1964) said that if mediation failed to occur, it could be due to the omission of any one or more of the three events. Profile analysis would also indicate if a deficiency in mediation was common to both the auditory-vocal and visual-motor communication channels.

ITPA research with retarded children has shown that these _S_s consistently manifest a gross impairment in overall psycholinguistic development, as indexed by their total LA scores (Ensminger & Smith, 1965). The picture is not clear cut, however, in regard to their representational level preformance. In a study by Mueller and Weaver (1964), 80 retarded children with a mean IQ of 42 and a mean MA of about 73 months obtained a mean score of 57.79 months on the representational level subtests. Although the significance of the difference between this last mean and mean MA was not tested, it seems obvious from other data reported that the difference of about 15 months would have been highly significant. This finding strongly supports a verbal mediation deficiency hypothesis. The Ss scored even lower on the automatic-sequential level tests though (mean = 52.26), suggesting that a deficiency in mediation at a meaningful level is part of a more general verbal disability in retardates.

The profiles presented by Bateman and Wetherell (1965), on the other hand, are not at all in accord with the verbal mediation deficiency view. These authors concluded that the outstanding feature of the profile for children with IQs below 75 "is a deficit in the entire automatic-sequential level as compared to the relative strength at the representational level

(p. 12)." But this statement is clearly lacking in generality, as Mueller and Weaver (1964) found that half of their Ss (the institutional group) scored lowest on vocal encoding (a representational level test). The same subgroup also obtained a lower mean on auditory-vocal association (at the representational level) than auditory-vocal sequencing. The other half of Mueller and Weaver's Ss (the day school group) scored slightly lower on vocal encoding than visual-motor sequencing.

More evidence is obviously required before any confident assertion can be made about the mediational ability of retardates on the basis of their ITPA performance. It would be very illuminating to study not just psycholinguistic development, but also the relationship of ITPA scores to performance on other discrimination and conceptual tasks. This would yield interesting data about the role of certain facets of verbal functioning in problem solving. Apart from correlations between global measures like total LA and MA, no work of this kind has been reported.

An additional consideration in discrimination learning research concerns the role of dimensional preferences. A number of studies have indicated that children may have dimensional preferences which affect the course of discrimination learning and shifting (Heal, George & Bransky, 1970; Smiley & Weir, 1966; Suchman & Trabasso, 1966; Trabasso, Stave & Eichberg, 1969; Wolff, 1966). It is possible, in fact, that mediation may be primarily a reflection of dimensional preferences. Thus Caron (1969) found in a brightness-height discrimination, that 3-year-old children trained with their preferred dimension relevant were significantly superior in both initial and reversal learning to Ss for whom the preferred dimension was irrelevant. The latter group, on the other hand, was significantly superior to the former in an ED shift. Dimensional preferences were assessed prior to discrimination learning by a matching procedure in which, for example, a tall white stimulus was presented as the standard, and short-white and tall-black stimuli presented for comparison. Ss were required to select the comparison stimulus which was most like the standard. Consistent selection by either height or brightness in seven out of eight trials was the criterion for determining Ss' preferred dimension.

Results such as Caron's are clearly antithetical to the Kendlers' theory, as they imply that the relationship between initial learning speed and choice of a reversal shift in an optional reversal problem could be a function of dimensional preferences rather than verbal mediation ability. On the other hand, such results are consonant with the attention model of Zeaman and House. However, the Kendlers do not consider that the demonstration of dimensional preference effects vitiates their theory. While agreeing that dimensional preferences are undoubtedly important (T. S. Kendler, 1964), they argued (Kendler & Kendler, 1969) that their developmental hypothesis had been supported in experiments in which dimensional dominance was adequately controlled through counterbalancing. Notwithstanding such arguments, it is advisable that experimental tests of verbal mediation theory be designed so as to take stimulus preference effects into account.

A final matter requiring comment here is the question of subject motivation. The importance of this issue for the present purposes is highlighted by the work of Zigler (1966, 1967), who argued that motivational rather than cognitive factors were responsible for the gross learning deficiencies found in mentally retarded children by Luria and Zeaman and House (and others to be discussed in Chapter 3). The cognitive defect versus motivational interpretations have recently been debated in the literature (Ellis, 1969; Milgram, 1969; Zigler, 1969), and the most tenable conclusion would seem to be that both sources contribute to learning disabilities in the retarded (Butterfield & McIntyre, 1969). This means that in investigations (such as the present one) concerned primarily with the cognitive basis of learning deficits in the retarded, an attempt should be made to maximize subject motivation. It has been found that a reliable way of achieving this, particularly when extended work is to be carried out with Ss, is to use a generalized reinforcer which can be exchanged for a variety of specific back-up reinforcements (Bijou & Baer, 1966). With this procedure the individual reinforcement preferences of Ss can be catered for, and the likelihood of specific satiation effects interfering with learning is reduced.

Conclusions

Although discrimination learning has been widely studied in _S_s at various ages and intellectual levels, no general consensus of opinion has yet been reached about the nature of the discrimination learning process, or the extent to which mentally retarded _S_s are deficient in discrimination learning. Major controversies have arisen over the role of verbal factors in learning, the existence of developmental changes in the ability of _S_s to mediate, and the relative performances of retardates and normals of similar MA.

Methodological issues appear to be at the heart of the existing confusions. It has been pointed out that the discrimination learning literature abounds in examples where potentially biased designs could have generated equivocal results. An additional reason for ambiguity being associated with many experimental tests of verbal mediation theory is due to the nature of the independent variables typically selected. Thus the majority of investigations into the role of verbal mediation in discrimination learning have either manipulated _S_s' overt verbalizations during learning, or contrasted the performances of <u>S</u>s at different developmental levels. Neither strategy provides a sufficient test of the relevance of covert verbal mediational processes to learning. The logic of this point is exemplified by the studies of Tighe and Tighe (1966, 1970), in which verbal labelling training was found to be functionally equivalent to perceptual training in regard to the facilitation of discrimination transfer, and age differences in discrimination transfer were found to be a function of the nature of the stimulus class involved.

To fill in some of the gaps in our knowledge, further research should be carried out with the total change of cues design. To date no work has been reported in which this design was used in a comparison of retarded and normal children of similar MA. But such an exercise would be an important step in establishing the extent to which retarded children are defective in mediational ability. By including in the research an objective measure of verbal ability such as the ITPA, a unique opportunity would be afforded for evaluating hypotheses concerning the role of verbal processes in discrimination learning and transfer, and the effect of verbal disability upon the conceptual behaviour of mental retardates.

Providing appropriate precautions were taken against the possible confounding effects of dimensional preferences, an investigation along the lines indicated would thus make a valuable contribution to two areas of psychology. It would have significance for general psychological theory concerning the nature of discrimination learning, and would provide important information about the extent and nature of basic learning deficits in the mentally retarded.

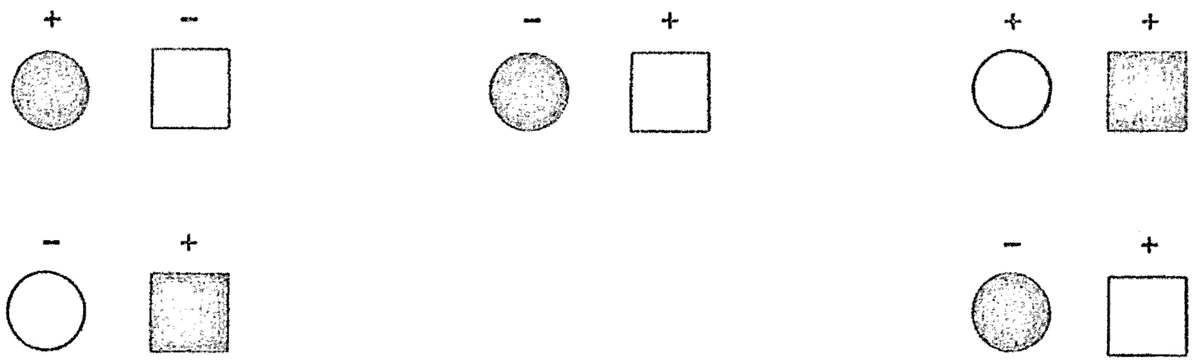
Chapter 2

Mediation in Discrimination Learning: Experimental

The research presented in this chapter was concerned with the role of verbal factors and mediation in the discrimination learning of retarded and normal children of similar MA. Four experimental tasks were administered: the ITPA and three two-choice simultaneous discrimination learning problems. The first discrimination problem served simply a pretraining function to familiarize Ss with the procedures. The second and third discrimination tasks (hereafter referred to as Experiments 1A and 1B, respectively) involved both initial learning (IL) and shift learning (SL) stages, and had colour and form as the two variable-within-trials dimensions. New cues were introduced on both dimensions for the SL stages (i.e., a total change of cues design was used). In Experiment 1A an ID shift followed IL, and in Experiment 1B an ED shift followed IL.

The specific purpose was to examine a number of predictions derived from the theories of Zeaman and House (1963), the Kendlers (Kendler & Kendler, 1962; T. S. Kendler, 1964), and Luria (1961, 1963). According to Zeaman and House, retardates are likely to show a deficit relative to normals of similar MA in the initial learning of colour or form discrimination tasks. This is said to occur because retardates have a lower initial probability of attending to these stimulus dimensions than do normals. It is also postulated that during the course of successful IL an S's probability of attending to the relevant dimension is raised. Consequently retardate-normal differences in performance are expected to be attenuated in shift problems which retain the same relevant dimension as IL (i.e., ID shifts). It was therefore predicted from the Zeaman and House theory that in Experiment 1A the retarded group would make more errors than the normal group in IL but not in SL (Hypothesis 1). Zeaman and House also indicated that the effects of dimensional transfer from IL to SL make ID shifts (in which positive transfer occurs) easier to learn than ED shifts (in which negative transfer occurs), regardless of the type of S. Thus it was further predicted that both subject groups would make more errors in the SL phase of Experiment 1B than in the SL phase of Experiment 1A (Hypothesis 2).

The Kendlers devised a technique (the optional reversal procedure) for determining the extent to which Ss continue responding in SL to the stimulus dimension which was relevant in IL. An example of an optional reversal task with colour as the relevant dimension and form irrelevant in IL is illustrated in Figure 1. The second stage presents an ambiguous problem in that it can be solved as either a colour discrimination, a form discrimination, or a colour-form discrimination. The third stage is used to test which of these alternatives the S presumably chose during Stage 2. In the present example, Ss who consistently choose white (irrespective of form) in Stage 3 would be considered to have made a reversal shift in Stage 2, and to have shown a high degree of dimensional transfer from Stage 1. Such Ss would be classified as mediators. On the other hand those who do not consistently choose white in Stage 3



Stage 1: initial learning

Stage 2: optional shift

Stage 3: test stage

Fig. 1. The stages involved in an optional reversal problem (T. S. Kendler, 1964).

would be considered not to have preferred a reversal shift solution in Stage 2, and to have shown no substantial dimensional transfer from IL. These Ss would be classified as non-mediators.

However it may not be appropriate to dichotomize Ss as mediators or non-mediators on the basis of their choices in an optional reversal for at least two reasons. Firstly, a number of investigators have suggested that performance in optional reversals is a function of Ss' dimensional preferences, rather than their ability to employ mediating processes (Smiley &

Weir, 1966; Suchman & Trabasso, 1966; Wolff, 1966). Secondly, as the optional reversal uses the same stimulus cues in IL and SL stages, the way is left open for biases, such as differential obviousness of postshift solution and negative instrumental response transfer, to confound the results (Slamecka, 1968).

These sources of bias are excluded when a total change of cues design is used, and in the present case Ss were classified as mediators or non-mediators on the basis of their performances in Experiments 1A and 1B. (The defining criteria for the classification are outlined on p. 52.) In addition, the design allowed mediation to be distinguished from behaviour which might have been due primarily to the operation of dimensional preferences. A combination of (a) the Kendlers' theory about the probable role of verbal processes in mediating discrimination learning with (b) Luria's analysis of the nature of verbal deficiencies in retardates, suggests that retardates would be likely to be grossly defective in their ability to mediate. Accordingly it was predicted that there would be a higher proportion of non-mediators in the retarded group than in the normal group (Hypothesis 3).

The Kendlers stated that non-mediators are inferior to mediators in both IL and IDSL. It is therefore a corollary of Hypothesis 3 that the retardates would make more errors than the normals in both the IL and SL stages of Experiment 1A (Hypothesis 4). It also follows from the Kendlers' theory that whereas mediators learn ID shifts more easily than ED shifts, non-mediators would not exhibit this differential. So a further corollary of Hypothesis 3 is that only the normal group would make more errors in Experiment 1B SL than in Experiment 1A SL (Hypothesis 5). It should be noted that Hypotheses 4 and 5 predict contrary effects to Hypotheses 1 and 2.

The conceptual similarity of certain aspects of the ITPA model to the theories of Luria and the Kendlers leads to inferences about the ITPA performance of retardates and normals, and mediators and non-mediators. Luria's view that retardates are grossly defective in verbal functioning (as well as research with the ITPA itself) suggests that retardates would score lower overall on the ITPA than normals of similar MA

(*Hypothesis 6*). Since defective use of verbal processes in mediating learning and behaviour was emphasized by Luria as the major feature of the retardates' verbal impairment, a further expectation is that the inferiority of the retardates would be most apparent on the representational level subtests of the ITPA (*Hypothesis 7*).

The Kendlers' view that mediation is probably dependent upon verbal development implies that mediators would score higher overall on the ITPA than non-mediators (*Hypothesis 8*). Furthermore, from the Kendlers' analysis of the components of the mediation sequence, it can be inferred that the ITPA superiority of mediators over non-mediators would be manifested primarily on the representational level subtests (*Hypothesis 9*).

Kendler (1964), who described mediation as a chain consisting of at least three elements (previously outlined on p. 26), stated that the non-occurrence of mediation could be due to the omission of any of the three events in the sequence. It was intended that if the above hypotheses concerning ITPA performance and mediation were confirmed, an attempt would be made to determine from an examination of ITPA subtest patterns the event or events in the sequence which contributed most to mediation failures.

Method

Subjects. The retarded group consisted of 41 pupils from the Queensland Sub-Normal Children's Welfare Association school in Townsville. Three criteria were used for selecting these Ss from the school population. No child was included who (a) had been attending school for less than one year, (b) possessed physical handicaps which would make it difficult to manipulate the apparatus, or (c) was unable to repeat simple verbal instructions. There were 25 boys and 16 girls. The age range was 8 to 16 years. The group was heterogeneous in terms of clinical category.

The normal group consisted of 40 4- and 5-year-olds who were attending pre-school kindergartens in Townsville. They were selected randomly from two pre-school centres, until a group similar to the retardates in mean MA was obtained. There were 18 boys and 22 girls.

The means and standard deviations of the Stanford-Binet (Form LM) MAs and IQs for the groups are presented in Table 1. The difference between the groups in MA was not significant.

No S in either group was suffering from defective vision or hearing, according to the reports of teachers.

Table 1

MA and IQ Means and SDs for Retardates and Normals

	Retardates (n=41)	Normals (n=40)	t
MA Mean	69.5 months	71.8 months	1.53; $p > .10$
SD	7.8	5.4	
IQ Mean	49.6	118.3	
SD	7.6	7.4	

Apparatus. Two familiar objects, a plastic ash-tray and a large spring-back paper clip, were used as the stimuli in the pretraining discrimination task. In Experiments 1A and 1B the stimuli were paper cut-outs differing in colour (red, yellow, green, or blue) and form (square, circle, triangle, cross, star, T, diamond, or hexagon). These were pasted onto white cardboard cards.

For the discrimination tasks the S and E sat facing each other with a one-way vision screen interposed. A 30x12 inch stimulus tray containing two circular reinforcement wells one inch in diameter and separated by 12 inches from centre to centre, could be presented directly in front of S by sliding it through a space beneath the one-way screen. On learning trials the stimuli were placed on the tray so that they covered the reinforcement wells. The apparatus is shown in Figure 2.

Token reinforcement was by way of cent coins which could be exchanged at the end of each session for a variety of back-up reinforcers (food, sweets, drinks, toys, stationery, and clothes).

Procedure. The program began with the administration of the ITPA. This was given at the start as it was the only task for which responses were not correlated with reinforcement. Within the following 4 weeks Ss were given three two-choice simultaneous discrimination

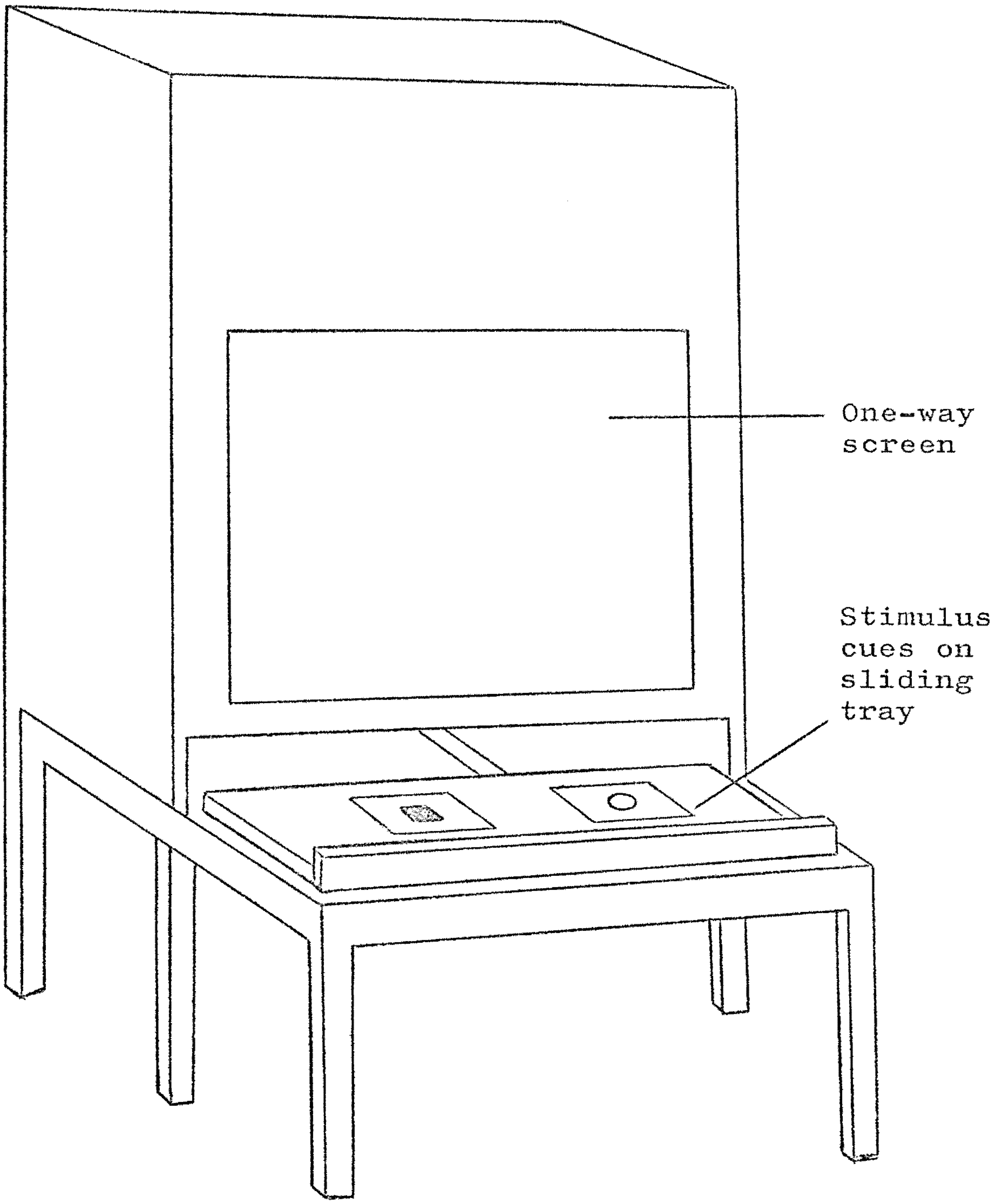


Fig. 2. Apparatus used in Experiments 1A and 1B.

tasks. In these tasks correct responses were reinforced both verbally ("Good" or "Right") and with the delivery of a cent coin. Incorrect responses were verbally punished ("No" or "Wrong").

The first discrimination (presented about a week after the ITPA) was a pretraining run to familiarize *Ss* with the experimental situation and the reinforcement procedure. At the start of the session *Ss* were shown the 'shop'--a table on which the back-up reinforcers were arranged. The *E* explained that *S* would be able to purchase from the shop when he had earned some money. An indication was given of the prices of the items. After being allowed a few minutes to inspect and manipulate the wares, *S* was taken to the other side of the room and shown the discrimination apparatus. The *E* explained that he would be sitting on the other side of the screen, and that when he pushed out the tray it would have two different 'things' on it. One of the 'things' would have a cent hidden under it but the other would not. The *Ss* were told that each time the tray came out they had to guess which 'thing' had the money under it. It was made clear to *Ss* that they could choose only one of the stimuli on each trial, and that they would only get the money if they chose correctly. On each trial *S*s were instructed to "pick up the one with the money under it", and they were encouraged periodically to "try to get it right every time so that you get a lot of money".

The stimuli used in the task were a plastic ashtray and a large spring-back paper clip. Half of the *S*s had the plastic ashtray as the positive cue, while the other half had the paper clip as the positive cue. The left-right position of the correct stimulus on each trial was determined by a Gellermann series. A non-correction procedure was used in this and the following tasks; that is, *S*s were allowed to make only one choice on each trial, and correction of errors was not permitted.

All *S*s were given 50 trials, at the conclusion of which they were invited to spend their money at the shop. They were permitted to buy items to the value of their earnings. They could save their money if they wished.

The second and third discriminations were, respectively, Experiments 1A and 1B. The two sets of stimuli used in Experiment 1A were red and blue triangles and squares, and yellow and green circles and crosses. For Experiment 1B the sets were red and green stars and hexagons, and blue and yellow diamonds and Ts. In each experiment Ss were randomly allocated one stimulus set for IL and the other for SL. The pairs of stimuli within each set were presented in random order. Figure 3 illustrates an example of stimulus arrangement for the two experiments.

For Experiment 1A form was relevant and colour irrelevant in both IL and SL. In Experiment 1B colour was relevant and form irrelevant in IL, with the reverse being the case in SL. Thus the sequence of relevant dimensions across the two experiments was form-form and colour-form. This arrangement equated the level of difficulty of the two SL problems. The order in which the experiments were presented was not counter-balanced, as it was considered undesirable to have half of the Ss learning three form discriminations in succession.

On each trial of the discrimination tasks Ss were instructed to look at the two pictures, and pick up the

	IL		SL	
	+	−	+	−
Experiment 1A	RTr	BSq	YCi	GCr
	+	−	+	−
	BTr	RSq	GCi	YCr
	form relevant		form relevant	
	+	−	+	−
Experiment 1B	RSt	GHe	BDi	YT
	+	−	+	−
	RHe	GSt	YDi	BT
	colour relevant		form relevant	

Fig. 3. An example of stimulus arrangement in Experiments 1A and 1B. Key: R=red; B=blue; Y=yellow; G=green; Tr=triangle; Sq=square; Ci=circle; Cr=cross; St=star; He=hexagon; Di=diamond; T=T.

one with the money under it.

The interval between pretraining and Experiment 1A was about one week, and between Experiments 1A and 1B about 2 weeks.

For the IL part of each experiment _S_s were run to a learning criterion of 9 correct out of 10 successive responses. _S_s not reaching this criterion in 80 trials were given special training. This consisted of showing

S the stimulus pairs in each set separately, and indicating the positive and negative members of each pair without referring to the colour or form.[6] This training demonstration was repeated every 20 trials until all Ss reached criterion.

The SL problems were introduced without any comment from E immediately Ss reached the IL criterion. Shift trials continued until S again reached a criterion of 9 correct out of 10 successive responses, or until 80 trials had been run. No special training was employed to facilitate shift learning. At the conclusion of the

[6] It should be noted that this special training method differed from that used by Campione (1970), Dickerson (1966), and Eimas (1966). These investigators paired the positive cues from each stimulus set and informed S that they were always the correct cues, and paired the negative cues from each stimulus set and informed S that they were never the correct ones. It was argued in Chapter 1 that this method of pairing the cues (which differs from the arrangement used on normal learning trials) may bias the likelihood of S acquiring a dimensional response.

shifts Ss were asked to state which picture always had the money under it, and which picture never had money under it.

On the basis of their performances in Experiments 1A and 1B Ss were classified as mediators, non-mediators, or dimensional preferers. To be categorized as a mediator, S was required to show evidence of mediation in both SL problems. This was defined as no errors before criterion on the ID shift of Experiment 1A, and some errors on the ED shift of Experiment 1B (not counting first trial SL errors as these could occur purely by chance). Ss who made no errors before criterion on both shifts were classified as shape preferers. Non-mediators were those who showed no evidence of mediation on either shift. They would be expected to make about the same number of errors on both shifts. Ss who made an equal number or fewer errors on the ED shift than the ID shift (excluding first trial errors) were classified immediately as non-mediators. However, those who made more errors on the ED shift could be either non-mediators or colour preferers. In order to determine which was the appropriate category for these Ss, a comparison was made of their IL errors. If IL errors in Experiment 1B (colour relevant) exceeded IL errors in Experiment 1A (form relevant), *S*s were classified as non-mediators. If the reverse was the case, *S*s were considered to be colour preferers.

Results

Hypothesis 1. The data relevant to Hypothesis 1 are summarized in Table 2, which shows the means and standard deviations of errors to criterion in the IL and SL stages of Experiments 1A and 1B. In determining the means for SL, *S*s who failed to reach the learning criterion in 80 trials were credited with an error score equal to the number of errors they made up to trial 80. It may be seen from the table that for Experiment 1A the retardates made significantly more errors than the normals in IL, but the SL means were almost identical. These results confirm the hypothesis that in Experiment 1A the retardates would make more errors than the normals in IL but not in SL. A further indication that the retardates were inferior to the normals in the IL stage of Experiment 1A is obtained

Table 2

Means and SDs of Errors to Criterion in IL and SL Stages of Experiments 1A and 1B

		Retardates (n=41)		Normals (n=40)			
Experiment 1A		Mean	SD	Mean	SD	t	p
	IL	29.5	22.7	14.3	15.7	3.47	< .001
	SL	5.7	11.6	5.8	12.0		
Experiment 1B							
	IL	22.1	25.4	23.4	20.2	0.25	
	SL	10.8	14.3	7.3	12.4		

by comparing the proportion of *S*s in each group who required special training to reach the IL criterion. From Table 3, which reports these data, it may be seen that a significantly higher proportion of retardates than normals required special training in Experiment 1A.

Table 3

Proportions of *S*s Requiring Special Training in IL

	Retardates	Normals	X^2	p
Experiment 1A	.49 (n=20)	.25 (n=10)	4.88	< .05
Experiment 1B	.27 (n=11)	.45 (n=18)	2.94	> .05

Hypothesis 2. In line with Hypothesis 2, Table 2 shows that both subject groups obtained a higher error mean in Experiment 1B SL than in Experiment 1A SL. The total means for all Ss in SL of Experiments 1A and 1B were, respectively, 5.7 and 9.1. To estimate the significance of this trend the data were submitted to an analysis of variance. As Bartlett's test did not indicate a lack of homogeneity of variance among the SL error scores (X^2=2.11), the analysis was carried out without transforming the raw data. The model followed was the unweighted means solution for repeated measurements on independent groups (Winer, 1962). A summary of the analysis of variance is presented in Table 4.

The significant main effect for experiments supports the hypothesis. However, Table 2 shows that the size of the SL differences was not equivalent in the two subject groups. Whereas the retardates averaged nearly twice as many errors in Experiment 1B SL as in Experiment 1A SL, the normals averaged only about 25% more errors in Experiment 1B SL. This suggests the possibility of an interaction between experiments and subject groups, although this interaction was not

Table 4

Summary of Analysis of Variance for SL Errors

Source of variation	Sums of squares	df	Mean square	F
Retardates/ Normals	121.305	1	121.305	1.0
Within groups	19862.486	79	251.424	
Experiment 1A/ Experiment 1B	453.340	1	453.340	6.04*
Expts X S gps	123.883	1	123.883	1.65
Expts X Ss within gps	5934.277	79	75.117	
Total	26495.291	161		

$*p < .05$

significant in the analysis of variance. Nevertheless, it is justifiable in terms of Hypothesis 2 to examine the contribution of each subject group to the Experiment 1A/Experiment 1B main effect. The results of follow-up *t* test comparisons of the differences between the SL means in each subject group indicated that the retardates were mainly responsible for the significant difference between experiments. This group made significantly more errors in the ED shift of Experiment 1B than in the ID shift of Experiment 1A ($\underline{t}$=3.74; $p < .01$), but the normals did not ($\underline{t}$=1.10). Consequently it was only in relation to the performance of the retardates that the hypothesis, predicting more errors in Experiment 1B SL than in Experiment 1A SL, received substantial support.

Hypothesis 3. In accordance with the procedure described above (p. 52), the Ss in each group were allocated to one of the four categories: mediator, non-mediator, form preferer, or colour preferer. The proportions of Ss falling into each category are shown in Table 5. It is obvious that the data do not support the hypothesis predicting a higher proportion of non-mediators in the retarded group than in the normal group. For analysis, the data in the table were condensed into three categories: mediator, non-mediator, and dimensional preferer. There was no significant difference between the proportions of retardates and normals in these three categories ($\underline{X}^2$=1.53; $p > .10$).

Altogether 75% of Ss were dichotomized as either

Table 5

Proportions of Mediators, Non-mediators, Form, and Colour Preferers

	Retardates	Normals
Mediators	.46 (n=19)	.35 (n=14)
Non-mediators	.34 (n=14)	.35 (n=14)
Form preferers	.12 (n=5)	.30 (n=12)
Colour preferers	.07 (n=3)	.00 (n=0)

Table 6

Mean Errors in ID and ED SL for Mediators and Non-mediators

	IDSL (Expt 1A)	EDSL (Expt 1B)	t	p
Retardates				
Mediators	0*	5.8	4.02	< .001
Non-mediators	15.9	15.8		
Normals				
Mediators	0*	9.6	2.71	< .02
Non-mediators	16.4	11.4		

* by definition

mediators or non-mediators. The statistical justification for this division is contained in Table 6, which shows the mean errors made by the subgroups in each SL task. Significantly more errors were made in the ED shift (Experiment 1B) than in the ID shift (Experiment 1A) by the mediators, but this was not the case for the non-mediators.

Hypotheses 4 and 5. As Hypothesis 3 was not confirmed, it is to be expected that neither Hypotheses 4 nor 5 would be confirmed. Reference to Table 2 shows this to be the case without the need for further analysis. The retardates did not make more errors than the normals in both the IL and SL stages of Experiment 1A (Hypothesis 4), nor was it the case that only the normal group made more errors in Experiment 1B SL than in Experiment 1A SL (Hypothesis 5). In fact, as has already been stated, the trend was in the opposite direction, with only the retardates making significantly more errors in Experiment 1B SL than in Experiment 1A SL.

Hypothesis 6. The performance of the two subject groups on the ITPA subtests and total LA is summarized in Table 7. It may be seen that the normals scored higher on all subtests except Motor Encoding. A repeated measurements on independent groups analysis of variance (unweighted means solution) was carried out on the ITPA subtest scores. The results of this are reported in Table 8. The difference between retardates and normals, between subtests, and the interaction were all significant. The significant main effect for subject groups confirms the hypothesis that the retardates would score lower overall on the ITPA than the normals. The overall superiority of the normals was also evident in a comparison of the total LA means (t=4.77; $p < .001$). By referring back to Table 1 it may be seen that the retardates' mean total LA was 10.1 months below their mean MA.

Hypothesis 7. In order to test the hypothesis that the inferiority of the retardates relative to the normals on the ITPA would be most apparent on the representational level subtests, the subtests at each level of organization were combined. The resulting subgroup means, SDs, and t values for differences between means, are shown in Table 9. Although

Table 7

Means and SDs (in Months) for ITPA Subtests and Total LA

Subtest	Retardates	Normals
Auditory Decoding		
Mean	60.3	66.3
SD	15.2	9.6
Visual Decoding		
Mean	66.9	69.8
SD	16.8	13.0
Auditory-vocal Association		
Mean	60.8	77.2
SD	14.8	9.8
Visual-motor Association		
Mean	61.6	68.8
SD	15.7	9.5
Vocal Encoding		
Mean	63.6	70.8
SD	18.0	19.3
Motor Encoding		
Mean	68.7	61.9
SD	15.5	11.0
Auditory-vocal Automatic		
Mean	47.0	67.7
SD	18.8	13.6
Auditory-vocal Sequencing		
Mean	50.0	81.5
SD	19.6	19.6
Visual-motor Sequencing		
Mean	62.4	70.1
SD	14.3	15.8
Total LA		
Mean	59.4	69.1
SD	11.8	4.6

Table 8

Summary of Analysis of Variance for ITPA Subtest Scores

Source of variation	Sums of squares	df	Mean square	F
Retardates/ Normals	19398.3	1	19398.3	30.95*
Within groups	49507.7	79	626.7	
Between subtests	7734.0	8	966.8	4.98*
S gps X Subtests	20046.8	8	2505.8	12.91*
Subtests X Ss within gps	122669.2	632	194.1	
Total	219356.0	728		

* $p < .01$

Table 9

Representational and Automatic-sequential Level Performances for Retardates and Normals

	Retardates		Normals			
	Mean	SD	Mean	SD	t	p
Representational	63.6	9.9	69.1	5.4	2.94	< .01
Automatic-sequential	53.1	13.9	73.1	9.6	7.31	< .001

significantly inferior to the normals at the representational level, the retardates showed a considerably greater deficit at the automatic-sequential level, which is not in accord with the hypothesis.

Hypothesis 8. The mean ITPA subtest scores obtained by mediators and non-mediators (not including Ss classified as dimensional preferers) are presented in Table 10. It is evident that while mediators tended to score higher than non-mediators in the retarded group (Columns 1 and 2), the reverse trend existed to some degree in the normal group (Columns 3 and 4), although the overall trend favoured the mediators for most subtests (Columns 5 and 6). The same pattern was apparent among the total LA means reported in Table 11. After correcting for heterogeneity of variance with a square-root transformation, the total LA scores were submitted to a least squares analysis of variance (summarized in Table 12). The main effect for subject groups, the main effect for mediation category, and the interaction were all found to be significant. The subject groups effect was, of course, simply a repetition (with a smaller N) of the result reported in Table 8.

Table 10

ITPA Subtest Means for Mediators (M) and Non-mediators (NM) Within Each S Group, and Combined Over Both S Groups

Subtest	Retardates M (n=19)	Retardates NM (n=14)	Normals M (n=14)	Normals NM (n=14)	All M (n=33)	All NM (n=28)
Auditory Decoding	65.5	55.4	64.9	64.9	65.2	60.1
Visual Decoding	68.8	65.1	66.2	69.1	67.7	67.1
Auditory-vocal Association	65.9	54.2	72.3	82.6	68.6	68.4
Visual-motor Association	67.6	50.1	67.6	68.4	67.6	59.3
Vocal Encoding	64.9	60.1	76.6	67.1	69.9	63.6
Motor Encoding	67.8	73.9	62.1	62.6	65.4	68.2
Auditory-vocal Automatic	49.6	41.9	65.4	65.3	56.3	53.6
Auditory-vocal Sequencing	57.7	36.4	68.6	93.3	62.3	64.9
Visual-motor Sequencing	66.1	55.8	66.9	74.4	66.4	65.1

Table 11

ITPA Total LA Means and SDs for Retarded and Normal Mediators and Non-mediators (Ns as in Table 10)

	Mediators		Non-mediators		Total Means
	Mean	SD	Mean	SD	
Retardates	64.1	12.2	53.0	5.6	59.4
Normals	67.0	5.5	70.6	3.6	68.8
Total Means	65.3		61.8		

Table 12

Summary of Analysis of Variance of ITPA Total LAs of Retarded and Normal Mediators and Non-mediators

Source of variation	Sums of squares	df	Mean square	F
Retardates/ Normals	6.13	1	6.13	25.54**
Mediators/ Non-mediators	1.21	1	1.21	5.04*
S group X Mediation category	3.17	1	3.17	13.21**
Error	13.83	57	.24	

* $p < .05$

** $p < .01$

Although the significant mediation category effect is in line with the hypothesis predicting superior verbal development in mediators than non-mediators, the result must be interpreted cautiously in view of the very obvious Subject group X Mediation category interaction. Follow-up *t* tests indicated that within the retarded group the inferiority of the non-mediators was highly significant (t=4.06; $p < .001$). Within the normal group the superiority of the non-mediators was not significant at the 5% level (t=1.19). Thus the normals' performance, while of course not supporting the hypothesis, was not actually contradictory to it.

Hypothesis 9. It was hypothesized that the ITPA superiority of mediators over non-mediators would be manifested primarily on the representational level subtests. A summary of the representational and automatic-sequential level performances of mediators and non-mediators is reported in Table 13. It may be seen that it was only in the retarded group that the non-mediators scored lower than the mediators at the representational level. Furthermore, while this difference was significant, an even larger difference obtained between

Table 13

Representational and Automatic-sequential Level Means and SDs for Mediators and Non-mediators

	Mediator		Non-mediator			
	Mean	SD	Mean	SD	t	p
Retardates						
Rep. level	66.8	4.7	59.8	5.2	2.62	< .02
A-S. level	57.8	6.5	44.7	5.2	2.81	< .01
Normals						
Rep. level	68.3	4.8	69.1	3.8	.38	
A-S. level	67.0	4.6	77.7	6.2	3.24	< .01

retarded mediators and non-mediators at the automatic-sequential level. The data therefore failed to support the hypothesis.

As clear-cut support for Hypotheses 8 and 9 was not obtained, no attempt was made to undertake an analysis of non-mediation on the basis of ITPA subtest patterns.

An additional piece of data concerns the answers given by Ss to the questions asked at the end of the discrimination problems. At the conclusion of

Table 14

Proportions of Correct and Incorrect Verbalizers at the End of Experiment 1A

	Retardates	Normals
Correct	.51 (n=21)	.60 (n=24)
Incorrect	.49 (n=20)	.40 (n=16)

Experiment 1A, <u>S</u>s were considered to have given a correct verbal account of their learning if they referred to form only in answer to the two questions: "Which picture always had the money under it?" and "Which picture never had money under it?" Any answer which did not refer to form, or which included reference to some other dimension (e.g., colour or position), was considered incorrect. The proportions of correct and incorrect verbalizers in each subject group is shown in Table 14. The difference between the categories was not significant ($\underline{X}^2$=.65). A similar analysis was not carried out for Experiment 1B, as the inclusion of both colour and form as correct dimensions made it difficult to judge reliably the correctness of Ss' answers.

Discussion

While the hypothesis predicting superior performance by the normals in IL of Experiment 1A was strongly confirmed, the subject groups did not differ significantly in IL of Experiment 1B. In terms of Zeaman and House's theory, these results would suggest that it was only with regard to form that the retarded group showed a lower initial observing probability than the normals. But Zeaman and House (1963) themselves reported that with two dimensional pattern stimuli colour discriminations were more difficult than form discriminations for retardates. However other studies (e.g., Heal, Ross & Sanders, 1966) have also not found retardate-normal differences in IL with colour as the relevant dimension. In the Heal et al. study this might have occurred because only relatively fast learners were used (Ss who failed to reach criterion in 40 trials were discarded), or because most of the retarded Ss were experienced in discrimination learning research.

In the present case too, of course, all *S*s were experienced by the time Experiment 1B began, and it may be the case that a limited amount of prior experience is all that is necessary to erase the retardates' gross IL deficit. Whatever explanation is eventually found to be correct, it seems that a gross deficit in the attention process is not a ubiquitous phenomenon amongst moderately retarded children, and when it does appear it may be fairly easily ameliorated (a criterion of 9 correct out of 10 successive responses in IL of Experiment 1A was all that was necessary to equate the learning of the subject groups in SL). It may also be noted in passing that the present results do not support the suggestion made by Denny (1964) that poorer IL by retardates than normals of similar MA is a function of the nature of the experimental situation. (A more detailed account of Denny's view is given in Chapter 3.)

No consistent pattern has emerged from earlier work comparing IDSL in retardates and normals. This led Wolff (1967) to conclude that the question of whether intelligence is functionally related to IDSL is still open. Methodological difficulties associated with the use of reversal and partial change shifts were probably largely responsible for the discrepant findings of previous research. The present Experiment 1A appears to be the first comparing retarded and normal children of similar MA with a total change ID shift design. The results indicated clearly that the subject groups did not differ in IDSL, which implies that intelligence is not related to the learning of 'pure' ID shifts. This is consistent with Zeaman and House's two-stage theory of discrimination learning.

The main body of research indicating defective mediational process development in retardates has been carried out by Russian investigators. Because of the paucity of descriptive information about Ss contained in the reports of this work, it is not possible to infer from it the extent to which a mediational deficiency would be characteristic of retardates classified according to Western criteria. A few paired-associate (Jensen & Rohwer, 1965; Penney, Seim & Peters, 1968) and optional reversal studies (Moon, 1968) have suggested that retardates may be less able to mediate than their normal MA peers, but no previous discrimination learning study has used an unequivocal methodology for determining the mediational capacity of retardates and normals. The present findings demonstrated that, at least at the MA levels considered, retarded Ss are no less able than their normal MA peers to exhibit mediational transfer in discrimination learning.

At a general level these results favour the Zeaman and House account and not the hypotheses derived from a combination of the views of the Kendlers and Luria. But certain more specific features of the data were contrary to Zeaman and House's position. A third of the Ss performed in such a way that they could be classified as non-mediators, and altogether 50% of the Ss did not make more errors in EDSL than in IDSL. These findings are in agreement with the Kendlers' contention that children between 5 and 7 years of age (i.e., MA) are in a transitional stage of mediational development. To account for the data in terms of attention theory, it would have to be argued here that the results were an artifact of using a weak IL criterion. But it would seem quite untenable to make this claim, in view of the fact that in Experiment 1A the

IL criterion was apparently strong enough to raise the retardates' presumably very low initial attending probability to a level as high as the normals' in the ID shift. A problem for both the Zeaman and House and Kendler-Luria positions is explaining why a greater ID-ED shift difference was found for the retarded group. While neither view would seem to be able to handle this finding easily, it fits perfectly with the notion that retardates experience greater difficulty in inhibiting negative transfer effects than normals of similar MA (Heal & Johnson, 1970). The role of inhibition deficits in retardate discrimination learning is examined in detail in the following chapters.

The exceptionally poor performance exhibited by the retarded group on the ITPA is in line with Luria's contention that a severe impairment in verbal development is an outstanding feature of mental retardation, and contrasts with the view that the retardates' verbal disabilities are no greater than would be expected on the basis of their MAs (Furth & Milgram, 1965; Spreen, 1965). But the further prediction derived from Luria's theory, that the retardates would primarily be deficient on the representational level subtests, was contradicted. Nevertheless, the results were not entirely inconsistent with the notion that a major aspect of the retarded child's verbal impairment has to do with a deficit in verbal mediating processes. The fact that the retardates' representational level mean was 6 months below their mean MA and significantly lower than the normals' representational level mean, suggests that a deficiency in verbal mediation at a meaningful level is part of the gross verbal disability characteristically found in mental retardates. Mueller and Weaver's (1964) findings support this interpretation. A possibility worth speculating about here, is that the extreme automatic-sequential level weakness generally found with mentally retarded Ss might be more a function of defective memory processes than verbal factors *per se*. If this was found to be the case, then there would be good grounds for singling out a deficiency in verbal mediation on the basis of research with the ITPA.

The design of the present study permitted a fundamental test of the Kendlers' hypothesis relating mediational ability in discrimination learning to verbal development. The fact that it was only in the retarded group that the predicted superiority of mediators over non-mediators on the ITPA occurred, raises serious doubts about the validity of the hypothesis, as it was initially advanced to account for the behaviour of normal children. It is not clear why the predicted effect appeared so strongly in the retarded group but not at all in the normal group. No similar research has been reported with which the present results can be compared. One might be tempted to argue in defence of verbal mediation theory, that the total LA means reported in Table 11 suggest the possibility that a verbal level of about 5 years is necessary but not sufficient for mediation. But this explanation is difficult to reconcile with the fact that the retarded and normal groups did not differ in terms of the proportions of mediators and non-mediators, even though only one normal S obtained a total LA of less than 60 months whereas 23 retardates (56%) scored below this level. Furthermore, nine mediators obtained total LAs of less than 60 months (the one normal S and eight retardates), with the lowest score being 50 months.

Comparing ITPA total LAs may actually be a rather coarse way of assessing the Kendlers' verbal mediation hypothesis, because in terms of the rationale set forward in Chapter 1 it is mainly on the representational level subtests that the inferiority of non-mediators relative to mediators is to be expected. When the representational and automatic-sequential level performances of mediators and non-mediators were examined separately, however, no additional support was found for the verbal mediation hypothesis.

Research demonstrating a relationship between Ss' stimulus preferences and their performances in discrimination learning and transfer tasks, is often taken as implying that mediation in the Kendler sense is merely a reflection of dimensional preferences (e.g., Caron, 1969; previously referred to on p. 30). The present study indicated, however, that at least in regard to colour and form dimensions, mediational ability can be distinguished from behaviour which appears to be determined primarily by stimulus preferences. Of course this is not to deny the possibility of dimensional preferences being held by mediators and non-mediators, or that in other circumstances dimensional preferers might behave like mediators or non-mediators. The point is that both mediational capacity and dimensional preference seem to be important factors influencing the course of discrimination learning in children.

In discrimination learning research the tendency has been to treat the notion of stimulus preference as if it refers to a relatively persistent learning set acquired outside of the experimental situation. Little consideration has been given to the extent to which preference hierarchies might be modified during an experiment. The present data suggest that nearly half of the Ss classified as form preferers (according to the criterion of no errors on both SL tasks) did not begin their learning with an overriding form dominance, but acquired this as the experiments progressed. Of the 17 form preferers, six were given special training in IL of Experiment 1A (where form was relevant), and another two, while not requiring special training, made fewer errors in IL of Experiment 1B (colour relevant) than in IL of Experiment 1A.

Verbal mediation theorists have frequently used post-experimental verbal reports as a guide to the level of verbal development of Ss. But it was found in the present case that while the retardates were markedly inferior to the normals on the ITPA, the subject groups did not differ significantly in terms of the proportions of correct verbalizers at the end of Experiment 1A. This suggests that the simple post-experimental verbal report technique lacks sensitivity as an index of children's verbal development.

Conclusions

While the data raised several problems for both attention and verbal mediation models of discrimination learning and retardate behaviour, by and large the results tended to be more consistent with the former position. The crucial findings in this regard were that the subject groups did not differ significantly in shift learning (and hence mediational transfer) even though the retardates were inferior in verbal ability, and that verbal development was not found to have a straight forward relationship with mediational ability.

The only result clearly favouring the Kendler rather than the Zeaman and House theory was that a valid distinction could be made between mediators and non-mediators (in the Kendler sense), and this implied that the Ss were in a stage of transition with respect to mediational development. It seemed clear that mediational capacity was not just a function of Ss' stimulus preferences.

Chapter 3

Inhibition Deficits in Retardate Discrimination Learning: Background

In a review of research on learning in the retarded, Denny (1964) contrasted Zeaman and House's (1963) evidence that retardates are inferior to normals of similar MA in discrimination learning with the results of Plenderleith (1956), Stevenson and Zigler (1957), and Stevenson (1960) in which retardate-normal differences were not found. It was suggested that the discrepant results arose from methodological differences between the studies. Zeaman and House presented their Ss with two-choice tasks in the impersonal WGTA (Wisconsin General Test Apparatus) situation, in which S and E are separated by a one-way vision screen. In the other studies S and E were in face-to-face contact, and in three of the four experiments by Stevenson three-choice tasks were used.

Denny argued that the divergent findings could be reconciled by postulating a general inhibitory deficit in the retarded. To support this postulate he cited evidence from classical conditioning in which retardates had been found to show increased resistence to extinction, difficulty in differential conditioning, and special susceptibility to disinhibition. One aspect of the inhibitory deficit was said to concern the retardates' deficient inhibition of competing position responses. Zeaman and House found that position discriminations are the easiest for retardates to learn. As each position is reinforced 50% of the time in a two-choice task but only one-third of the time in a three-choice task (that is, when position is irrelevant and randomly varied from trial to trial), it could be the case that position responding would interfere more with retardate behaviour than with normal learning in a two-choice situation. Also, Ss might be less likely to display initial position preferences when confronted with three choices. A more important aspect of the inhibitory deficit than interference from position habits, according to Denny, is the retardate's general inattentiveness. In the impersonal WGTA situation the defective may be more likely to show a lack of attention to the task[7], than if S and E interact informally in a face-to-face situation.

There are two points which should be noted here in regard to Denny's argument, however. Firstly, experiments in which S and E are in face-to-face contact are far more susceptible to bias from Rosenthal (1966) type effects than situations in which S and E are separated. In fact this is a major reason why a more impersonal situation has been widely employed in discrimination learning experiments. Secondly, Denny included "an inability to maintain an orientation for the relevant stimuli" (his attention deficit) under the rubric of an inhibition deficiency. But this may be related to a weakness in the orientation reflex, in which case the locus of the deficit would be in the excitatory rather than the inhibitory processes. There is quite a deal of support for the notion that the frequently reported

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7 Usually when Denny spoke of an 'attention deficit' he implied a lack of attention to the task as a whole. Zeaman and House (1963) used the concept in a more restricted sense to mean attending to the wrong aspect of the task.

inattentiveness or distractibility of retardates stems from weaknesses in the orientation reflex (Heal & Johnson, 1970).

An inhibition deficiency has also been suggested as a determinant of discrimination disability in retardates by Diamond, Balvin and Diamond (1963), Heal, Ross and Sanders (1966), House, Orlando and Zeaman (1957), Lobb (1966), Luria (1963), Riese and Lobb (1967), and Zeaman (1959). However, Zeaman and House (1962) reached the conclusion that retardates did not seem to differ from other types of *S*s with respect to inhibitory processes based on nonreward.

The experiment by Lobb (1966) was concerned with the contribution of interfering position habits to the retardates' discrimination learning disability. To attenuate the tendency to develop position habits, experimental *S*s were given extra nonreward trials with irrelevant stimuli. This procedure was successful in eliminating the development of strong position preferences, although it did not correspondingly facilitate approach-avoidance learning for all *S*s.

In a follow-up study, Riese and Lobb (1967) hypothesized that the persistence of errors in the absence of position habits might be due to the retardates' inability to inhibit responses to the relevant negative cue. The Ss in the study were institutionalized retarded children with a mean IQ of 31.3 and a mean MA of 38.9 months. A WGTA arrangement was used to present the tasks--two-choice simultaneous object discriminations. Screening sessions were given to eliminate fast learners from the experimental groups. The treatments consisted of varying Ss' experience with relevant positive, relevant negative, and irrelevant negative stimuli, prior to trials on the main learning problem. The results indicated that significantly fewer errors were made by groups who had been pretrained with relevant negative stimuli than by those pretrained with relevant positive cues. Also, in line with the earlier study by Lobb, discrimination was found to be facilitated by pretraining in which two irrelevant negative stimuli were presented on each trial. The investigators concluded that their findings supported the view that retardate discrimination learning is enhanced by training which compensates for deficits in conditioning inhibition of approach to the negative cue, and inhibition of competing position responses.

Riese and Lobb added that their results were not deducible from Zeaman and House's theory, as attention to the relevant dimension should occur with about equal ease under both relevant positive and relevant negative training conditions. But this may not be the case. The relevant positive condition, in which S is reinforced on every trial, could easily lead to the acquisition or strengthening of an inappropriate observing response. It should also be noted that as a normal comparison group was not included in the study, the results do not directly imply the existence of an inhibition deficit in retardate discrimination learning.

In a review of research relating to inhibition deficits in retardate learning, Heal and Johnson (1970) concluded that simultaneous discrimination learning studies have produced only meagre evidence of a retardate deficit in inhibiting responses to the negative cue. But the presence of confounding aspects in a good deal of the work makes interpretation of results difficult. In order to compare approach to the positive cue with avoidance of the negative cue, many investigations used a cue-substitution paradigm in which either the positive or negative cue was replaced with a new cue after IL. From the degree of interference produced by the substitution, inferences were drawn about the relative potency of the positive and negative cues in the Ss' learning. A serious weakness of this design is that it confuses stimulus novelty effects with the assessment of approach and avoidance tendencies. As an alternative Heal and Johnson recommended the use of the ambiguous cue problem, which they claimed had much to offer as a methodology for the study of inhibitory processes. In this problem one of the three cues used is ambiguous in that it is positive when paired with the second cue, but negative when paired with the third cue. The relative difficulty Ss experience in learning the correct choice response for each stimulus pair is taken as the measure of the strength of approach and avoidance tendencies in the Ss' learning. Heal and Johnson cited two studies of ambiguous cue problem solution in retarded Ss, neither of which supported the inhibition deficit hypothesis. However, again the value of the technique is questionable. As is usual in all simultaneous discriminations, Ss were required to make a response on every trial. But the fundamental issue here pertains to the inhibition or withholding of responses, and no independent measure of this aspect of behaviour was available.

Because of the difficulty of obtaining a straightforward assessment from simultaneous discriminations of an S's ability to inhibit responses to the negative cue, Ross (1966) advocated the use of a 'go-no go' procedure in which the discriminanda are presented successively. He cited an unpublished experiment by Yaeger using this paradigm, in which retardates and normals were compared in acquisition and reversal of a free operant discrimination. The groups were not found to differ in percentage of responses to the positive cue during acquisition, but in reversal the normals' performance was significantly superior to that of the retardates. Amplitude of responses was also recorded in order to measure inhibition in the sense of 'work minimization'. The normals were found to make responses of significantly smaller amplitude than the retardates. This result was considered to support an inhibition deficit notion of retardate performance.

Much of the research dealing with successive discrimination learning in retarded Ss, particularly that concerned with inhibition as an explanatory concept, has been conceived within a classical conditioning framework. In a review of classical conditioning studies in mental retardation, Astrup, Sersen and Wortis (1967) reported that "the findings pertaining to strength of the inhibitory processes uniformly indicate that the inhibitory processes tend to be weak in oligophrenic children (p. 522)," although "simple elaborations of positive and negative conditional reflexes are easily achieved (p. 513)," and "even considerable mental retardation would be compatible with rapid negative reflex formation (p. 520)." These latter two statements suggest that retardates might be no more deficient than their normal MA peers in learning to withhold responses to the negative cue. However, Luria (1963) reported that although the formation of simple positive connections in oligophrenic children may not be disrupted, disturbances are observed in the production of simple differentiations. "While ... simple differentiations are usually established by a ... (normal) child of 8 or 9 after one or two combined presentations of the differential signal and the order 'Don't press', for many child-oligophrenics 3-5 or even more presentations are necessary (p. 120)." Moreover, both positive and negative connections are less stable in oligophrenic children.

Luria's findings are not fully consistent with the conclusion of Astrup _et al._, but a lack of sufficient descriptive and statistical detail makes it impossible to determine if his results indicated a greater deficit for retardates than normals of similar MA in inhibiting responses to the negative cue. Luria apparently compared 8- and 9-year-old normals with 9- to 12-year-old oligophrenics. In general, in fact, the insufficient reporting of details makes it impossible to take full account of a good deal of the Russian conditioning work for the present purposes.

In his report of Yaeger's study, Ross (1966) did not account for the retardate-normal difference appearing in reversal when it had been absent in acquisition. A plausible explanation is that retardates have greater difficulty than normals in inhibiting a previously acquired habit. This interpretation has been suggested for a number of similar findings in simultaneous discrimination learning (Heal et al., 1966; Heal & Johnson, 1970). The persistence of inappropriate position habits could also be explained in these terms, although Zeaman and House (1963) have postulated a different mechanism to account for this particular case. In fact their theory predicts the opposite to the results of Yaeger; namely, that retardate-normal differences will be greater in IL than in reversal. In Yaeger's study only one manipulandum was used, so there was no question of position habits interfering with learning.

The notion that retardates experience exceptional difficulty in reversal learning and other tasks which require S to switch responses in the presence of an unchanged stimulus has been advocated for many years. Traditionally the problem has not been conceived in terms of an inhibition deficit however, but as an indication of underlying rigidity, inertness, or a lack of mobility of mental processes (Kounin, 1941; Lewin, 1936; Luria, 1963; Pevzner, 1961). Despite the considerable history of these 'inflexibility' conceptions of retardate behaviour, and the implications which they have had for the training and treatment of retardates, the data from a number of experiments are inconsistent with the general position (Plenderleith, 1956; Stevenson & Zigler, 1957; Zigler & Butterfield, 1966; Zigler & De Labry, 1962; Zigler & Unell, 1962). In one study (O'Connor & Hermelin, 1959) retardates were actually found to reverse a size discrimination more quickly than normals of similar MA.

Such results led Zigler (1962, 1966, 1967) to argue against the rigidity characterization of retardate performance. He proposed (as previously indicated on p. 32) that if retardates are found to perform more poorly than normals of similar MA in intellectual tasks, this is due to differences in motivation rather than to cognitive factors. Although this argument was launched originally against the Lewin-Kounin rigidity formulation, it has since been directed at all theories advocating a cognitive basis to performance differences between retardate and normal MA peers.

Conclusions

It seems that a considerable range of retardate behaviour anomalies can be interpreted in terms of an inhibition deficiency hypothesis. This makes it tempting to draw the conclusion that an inhibitory deficiency is characteristic of retardates. But the validity of this inference depends upon a consistent pattern of experimental results, and in the field of discrimination learning this has not emerged. While the results of a number of studies are suggestive of some kind of gross inhibition deficit in retardate discrimination learning, it is hazardous to venture confident pronouncements about the nature of the deficit, or how it is manifested. Among the reasons for this are the dearth of discrimination learning experiments designed specifically to test the inhibition deficit notion, the presence of confounding aspects in the design of much of the relevant work, and the variety of connotations of the term 'inhibition deficit'.

The present state of affairs is exemplified by the studies of Riese and Lobb (1967) and Yaeger (reported by Ross, 1966), which were both concerned with inhibition in the sense of withholding responses to the unreinforced (relevant negative) cue. The former study suggested that an inability to cease responses to the negative cue during acquisition was an important factor in retardate discrimination learning. Only retarded Ss were used however, so we do not know if normals would have performed differently. Yaeger's study compared retardates with normals, and did not find the groups to differ in percentage of responses to the negative cue during acquisition. It was concluded, nevertheless, that the study lent support to an inhibition deficit theory, because the retardates' responses were of greater amplitude than the normals'.

There were many differences between these two studies which could have been responsible for any discrepancy in the findings. Riese and Lobb's was an experimenter-paced simultaneous discrimination in which a reward was available on every test trial (not on all training trials). In the successive free operant task of Yaeger, on the other hand, the negative stimulus always signalled a period of no reinforcement regardless of whether S responded or not. Perhaps extinction of responses to the negative stimulus occurs more rapidly in the free operant situation. Interspersing periods during which no reinforcement was available regardless of the response was, after all, the technique that Riese and Lobb used to accelerate extinction.

It is important that further research attempt to establish conclusively the status of the inhibition deficit conception as an explanation of retardate learning disabilities. Two major issues in need of resolution concern the ability of retardates (a) to inhibit responses to the negative cue in discrimination learning, and (b) to engage in new learning which entails inhibiting habits already established.

Investigations relevant to the first matter have yielded, at best, inconsistent evidence that retardates are less able than their normal MA peers to inhibit responses to the negative cue. But in the case of instrumental discrimination learning studies, the experimental technique has rarely been adequate for the task. To obtain definitive evidence it is necessary to employ a methodology which permits approach and avoidance tendencies to be assessed independently. The simplest and probably most satisfactory tactic for the purpose (which has been almost entirely overlooked by other researchers in the area) is to present the positive and negative cues separately on successive trials, and require the S to either respond or not respond on each trial. It is only with this method that independent measurements can be obtained for all four response possibilities in the two-choice situation--responding to the positive cue, not responding (inhibiting) to the positive cue, responding to the negative cue, and inhibiting to the negative cue.

A number of controversies impinge upon the issue of whether retarded and normal children of similar MA differ in performance in tasks which involve the inhibition of previously acquired habits. While Heal and Johnson (1970) considered there to be persuasive evidence that retardates are inferior to their normal MA peers in such tasks, they tentatively suggested that the retardate's deficit may be in flexibility rather than inhibition. Zigler (1966) has strongly opposed at both a theoretical and empirical level the possibility of retardates being any less flexible in their learning processes than normals of similar MA. Taking discrimination reversal (a type of ID shift) as a typical example of the sort of task in question, attention theory (see Chapter 1) would not predict any particular difficulty for retardates. On the other hand verbal mediation theory (see Chapter 1) has a ready explanation for a retardate deficiency if it does occur. As the whole issue has wideranging implications for the training and employment of the mentally retarded, there is a vital need for clarity to be achieved in the area.

Four discrimination learning experiments are reported in the next chapter which investigate these critical facets of the inhibition deficit notion of retardate performance.

Chapter 4

Inhibition Deficits in Retardate Discrimination Learning: Experimental

The general purpose of the research reported in this chapter was to determine whether moderately retarded children are more deficient than normals of similar MA in learning to inhibit responding to the negative cue in discrimination tasks, and in learning shift problems in which previously established habits have to be inhibited. The four experiments used a successive method of stimulus presentation, and in each task Ss were required (a) to make an overt response (pushing a button) to one stimulus (generally referred to as the positive cue), and (b) to withhold this response to another stimulus (generally referred to as the negative cue). The Ss were the same children as employed in the previous experiments (Chapter 2). The present series commenced 2 weeks after the completion of Experiment 1B, and a period of between one and 2 weeks separated the four experiments in the series.

The first experiment (Experiment 2) investigated both inhibition of responses to the negative cue, and performance in a task where previous learning had to be suppressed. The task was an experimenter-paced discrimination reversal, in which a reward was given for correct avoidance behaviour (not responding to the negative cue) as well as for correct approach behaviour (responding to the positive cue). By using this balanced reinforcement design approach and avoidance tendencies were not confounded with a reinforcement differential. A record was taken of errors made in the presence of both the positive and negative cues, and of total errors in IL and RL (reversal learning).

Experiment 3 studied the ability of Ss to alter a simple response stereotype. The procedure was essentially the same as the IL stage of Experiment 2, apart from changes in the order and duration of stimulus presentation. After practising a single alternation response habit, Ss were required to switch to a non-alternating response sequence. The main dependent variable was number of errors made following the switch.

Experiment 4 was a partial replication of a free operant discrimination reported by Barrett (1965). This had suggested, but by no means conclusively, that in the acquisition of a discrimination retarded children exhibit a variety of deficits which are more specific in nature than an inability to inhibit responses to the negative cue. Experiment 4 was undertaken partly to check the generality of Barrett's findings. In addition to acquisition the task in Experiment 4 included a period of extinction. This permitted the inhibition of a previously established habit to be investigated in a situation where there was no superimposed new learning. So that performance in this situation could subsequently be compared with performance in a highly similar task involving a new learning requirement, Experiment 5 consisted of a free operant reversal problem. It was anticipated that a comparison of reversal and extinction performances would reveal whether (a) a lack of inhibition of previous habits, or (b) inflexibility, was responsible for a reversal deficit.

Experiment 2

Inhibition of Responses to the Negative Cue and Reversal Learning in Retardates and Normals

In a conventional two-choice discrimination learning problem the S is required to respond consistently to one set of stimuli (the positive cues), and avoid consistently or not respond to another set or sets (the negative cues). One version of the inhibition deficiency view suggests that retardates perform poorly in discrimination tasks because they experience difficulty in learning to withhold responses to the negative cue. This implies that defective negative cue learning rather than poor positive cue learning is at the base of the retardate's discrimination learning deficit; that it is the tendency to exceed the normal in negative cue errors but not in positive cue errors which distinguishes the retardate's discrimination learning.

In the main, three experimental paradigms have been used to assess the ability of Ss to learn to withhold responses to the negative cue in discrimination tasks; simultaneous discriminations, free operant discriminations, and classical conditioning of motor differentiations. The first of these techniques is not appropriate as it confounds positive and negative cue learning. If the stimuli are presented successively, however, as is usual in classical and free operant conditioning, behaviour in the presence of the positive and negative cues can be observed independently.

Neither classical nor free operant conditioning has led to definitive results about the relative ability of retardates and normals to deal with negative cue learning. Conflicting classical conditioning evidence is reported by Astrup *et al.* (1967) and Luria (1963). In the case of operant conditioning, too few studies have reported comparative data to allow significant conclusions to be drawn. Methodological differences between the classical and operant paradigms may mean that the two techniques are not measuring the same ability anyway. In the usual classical conditioning paradigm for establishing motor differentiations, the *S* is *instructed to respond* when one stimulus is presented (the positive cue), and *instructed not to respond* when the other stimulus is presented (the negative cue).

Here, cue value (positive or negative) is defined in terms of the behavioural requirement (respond or not respond). In operant conditioning, on the other hand, cue value is defined primarily in terms of reinforcement criteria. The _S_ is rewarded for responses made during presentation of the positive cue, and not rewarded (regardless of behaviour) during presentation of the negative cue. A reinforcement differential like this is not coupled with the cues in classical conditioning. Thus the classical conditioning paradigm measures more or less pure behavioural control, under conditions of equivalent consequences for correct choices to the positive and negative cues. The free operant paradigm, on the other hand, measures the behavioural consequences of reinforcement.

It is debatable whether the view that retardates are defective in inhibiting responses to the negative cue refers primarily to (a) questions of behavioural control _per se_, or (b) the effects of non-reward, or (c) both matters. The fact that such uncertainty is possible makes it important that further work be carried out, particularly in view of what seems to be a widespread belief that 'some kind' of inhibition deficit is characteristic of much retardate behaviour. One important question that does not appear to have been studied at all, is whether retarded children experience difficulty in learning to withhold a response when rewarded for doing so. Case studies (e.g., Patterson, 1965) have reported success in using this technique, rather than extinction or punishment, to control the behaviour of hyperactive children.

The first purpose of the present experiment was to investigate the ability of retarded and normal children of similar MA to withhold responses to the negative cue in a discrimination task, under conditions in which all correct choices were rewarded. So that it could be clearly determined whether a deficit in discrimination learning resulted from a tendency to make more negative cue errors alone, an experimenter-paced successive presentation design was used which allowed positive and negative cue errors to be recorded separately. Using the token economy reinforcement system devised for the previous experiments, Ss were rewarded both for pressing a button in the presence of the positive cue and for refraining from pressing in the presence of the negative cue. Thus the experiment studied the inhibition deficit hypothesis from the point of view of behavioural control, as equivalent consequences were provided for all correct choices.

The discrimination task consisted of both acquisition and reversal stages. One of the most controversial issues in the retardate discrimination learning literature concerns the ability of Ss to learn reversals and other tasks involving negative transfer from prior learning. While there is mounting evidence suggesting that retardates experience greater difficulty in these situations than normals of comparable MA (Heal & Johnson, 1970), conflicting explanations have been advanced to account for the retardates' deficit. The main question disputed is whether cognitive or motivational factors are responsible for the deficit. One approach to resolving the problem is to study reversal learning under conditions in which motivational factors are equated or controlled across subject groups. On the assumption that the token economy system would tend to control motivation by maximizing it for all Ss, the second purpose of the experiment was to compare the subject groups in reversal learning under conditions designed to produce a high level of motivation.

It is generally assumed that a reversal learning deficit stems from the S's difficulty in learning the new responses for both the positive and negative cues. However, this has not been proved as separate measures of approach and avoidance learning are not obtained from the usual simultaneous or free operant discrimination learning designs. The present design permitted the development of approach and avoidance tendencies to be traced individually during RL.

Method

Subjects. The children who had acted as Ss in the previous experiments were also used in this and the following experiments. Due to one retarded child having left the school, 40 retarded and 40 normal Ss took part in this experiment. The omission of this one S reduced the mean MA of the retarded group from 69.5 months to 69.2 months.

Apparatus. The stimuli were square blue or yellow patches. A Kodak Carousel projector was used to display these onto a rear projection screen. The projected images were approximately 6 inches square.

A device for dispensing cent coins into a plastic dish was placed on the left of the stimulus screen.

The manipulandum was the hand control mechanism from a Scalextric model car set. This was connected to a pen recorder which indicated the amplitude and duration of each response on a moving paper tape. A second pen on the machine could be manually operated by E to record stimulus onset and offset.[8]

The pen recorder was housed in a wooden cubicle in which E also sat. The cubicle had a one-way vision panel in the front of it, which enabled E to observe S from a distance of approximately 4 feet.

The apparatus as viewed by the S is shown in Figure 3.

Procedure. The slides were loaded into every second slot of the 80 slide magazine on the projector.

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[8] The response and recording apparatus was kindly lent by Mr. B. Cambourne, of the James Cook University of North Queensland.

The alternate slots contained pieces of non-transparent cardboard, which provided dark intervals between each stimulus.

The stimuli were presented successively, with the order of the two colours being determined randomly (with the restriction that neither was presented more than three times in a row). The interval-timer on the projector was set so that stimulus presentation time was 2 seconds. This made the inter-stimulus interval about 4 seconds, as the slide change mechanism took approximately one second to operate.

As the Ss were being brought individually into the experimental room they were told that they were going to play a new game today, and that they should be able to earn a lot of money. They were allowed to inspect the wares on sale in the shop before being taken to the other side of the room and seated in front of the screen.

The action of the manipulandum was demonstrated, and Ss were requested to "have a few goes". They were then instructed that they were to see two colours, and that for one they had to press the button while for the

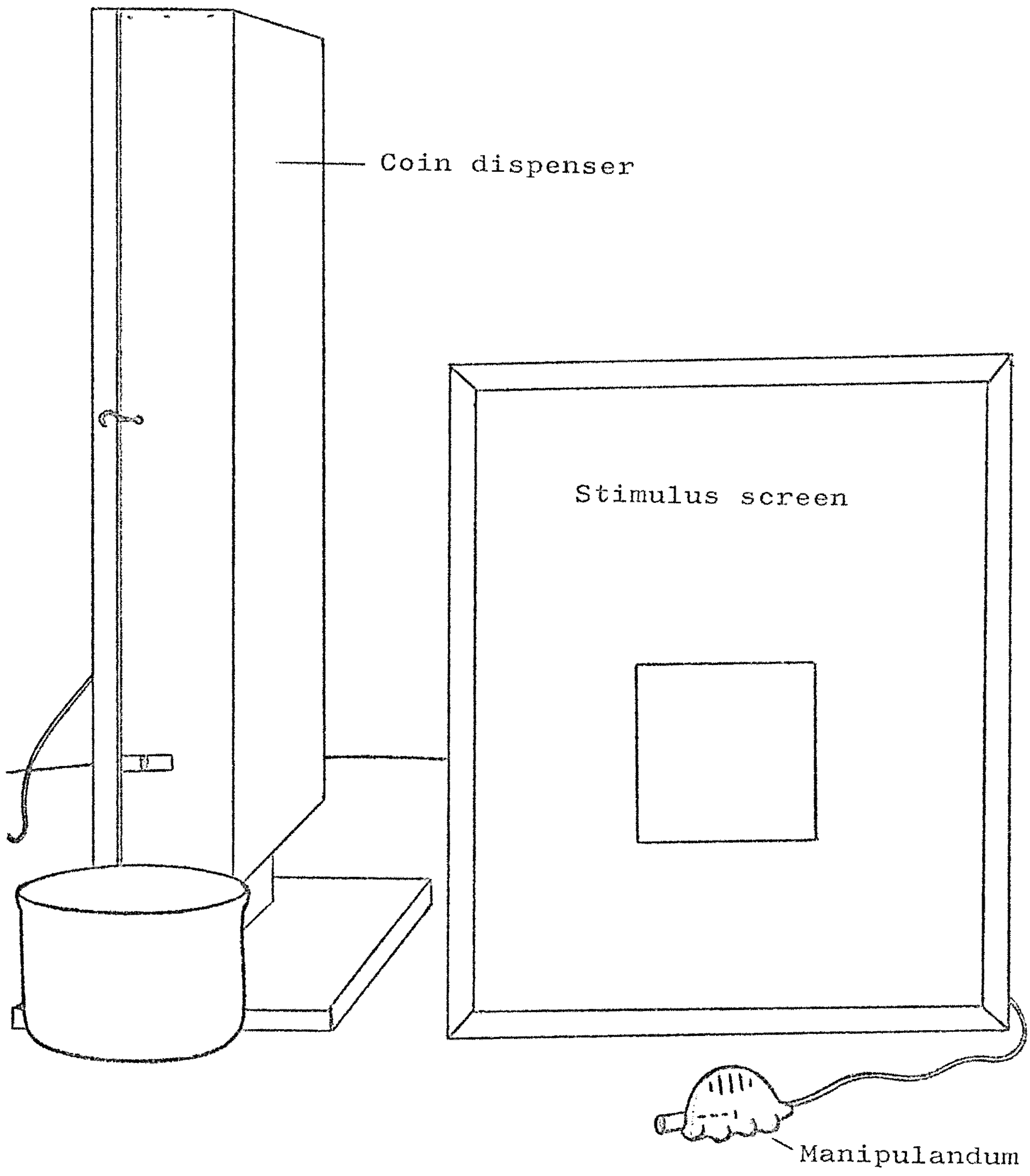

Fig. 3. Apparatus used in Experiments 2 and 3.

other they had to refrain from pressing. They were encouraged to try to get it right every time, as this was the best way to get a lot of money.

The positive and negative colours were chosen randomly for each S.

Each correct 'response' (press or not press) was reinforced verbally ("Good" or "Right") and with the delivery of a cent coin. Incorrect responses were verbally punished ("No" or "Wrong"). In the case of positive cue responses (presses) reinforcement was delivered immediately the response was made. For correct negative cue choices (not pressing) reinforcement was delivered at the end of the 2-second stimulus interval.

Ss were run until they reached a criterion of 9 correct out of 10 successive responses, or for 80 trials. Immediately criterion was reached reversal training began, without any comment from E. Ss failing to attain the IL criterion in 80 trials were not given the reversal. Reversal training continued until a 9 out of 10 criterion was reached, or for 80 trials.

At the conclusion of the experiment Ss were invited to spend their money at the shop.

Results

Errors to criterion (or total errors in 80 trials for non-criterion Ss) were the raw data used in the analyses. An initial intention to examine also the amplitude and duration of responses was abandoned due to the unreliability of the recording apparatus in indexing these variables.[9]

The mean errors made by the subject groups during IL and RL are shown in Table 15. It may be seen that (1) in IL the retardates made less errors than the normals for both cues; (2) in RL the retardates made approximately twice as many errors as the normals for both cues; (3) both subject groups made more negative

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[9] Two faults developed in the recording apparatus. Occasionally the paper tape ran off the tracking splines. This erroneously showed up on the record as a change in response amplitude. There was also a tendency for the motor driving the paper tape to vary in speed. This introduced an error into the measure of response duration.

Table 15

Mean IL and RL Errors and SDs

for Retardates and Normals

	Retardates		Normals	
	Mean	SD	Mean	SD
IL				
Negative cue errors	2.8 (n=40)	5.1	4.2 (n=40)	6.6
Positive cue errors	1.5	5.0	1.7	2.7
Total errors	4.3	9.5	5.9	9.1
RL				
Negative cue errors	8.5 (n=39)	9.0	4.1 (n=38)	4.3
Positive cue errors	3.3	6.8	1.8	1.4
Total errors	11.8	12.0	5.9	4.7

Note: the *N*s for RL are less than for IL because one retardate and two normals failed to reach the IL criterion and were not given reversal trials.

cue errors than positive cue errors; (4) the retardates made more errors in RL than in IL; and (5) the normals obtained the same mean total error score in IL and RL.

The data in Table 15 indicate, without the need for further analysis, that the retardates did not exceed the normals in terms of negative cue errors alone. The retardate-normal differences in IL and RL total errors, and the difference between the retardates' IL and RL total error scores, were evaluated by *t* tests. These analyses indicated that (1) the subject groups did not differ significantly in IL (t=0.76), (2) the retardates made significantly more RL errors than the normals (t=2.78; $p < .01$), and (3) the retardates made significantly more errors in RL than in IL (t=4.94; $p < .001$).

Discussion

In IL the retardates performed as well as the normals in terms of both negative cue errors and total errors. Thus in IL the retardates were not deficient in either discrimination learning or in their ability to withhold responses to the negative cue. In RL the retardates exhibited a deficiency, as they made significantly more errors than the normals. However, this did not stem from an increase in negative cue errors alone. In RL the retardates made approximately twice as many errors for both cues as did the normals.

Consequently, the experiment provided no grounds for singling out a negative cue learning deficit for the retardates. Even when their error score was excessively high, it was not sufficient to attribute their learning deficiency to an inability to inhibit responses to the negative cue.

The appearance of a retardate-normal difference in reversal when it had been absent in IL is consistent with the findings of several other investigators (Heal & Johnson, 1970). The present experiment adds to the previous work by showing how the positive and negative cues contributed to the retardates' RL deficit. The data indicated that it is correct to assume that a reversal deficit stems from defective acquisition of both the new approach and the new avoidance habits. It cannot be argued that the retardates' inferiority in RL was due to poor or inappropriate motivation. Apart from the fact that a deliberate attempt was made to maximize motivation, the absence of a difference between the subject groups in IL strongly suggests that they were adequately matched in terms of motivation to learn in the situation. Therefore, it seems that the reversal disability must be explained in terms of some cognitive process crucial to reversal learning itself. Until further evidence is obtained (see Experiments 4 and 5), either an inability to inhibit previously acquired habits or a lack of flexibility of learning processes can be proposed as the likely basis of the retardates' reversal deficiency.

Contrary to the present results is the view that retardate-normal differences will be less in the transfer stage than in IL when an ID paradigm is employed (Zeaman & House, 1963). A reversal is, of course, an ID shift as the same stimulus dimension (colour in the present experiment) remains relevant throughout both stages. Zeaman and House's prediction is based on the hypothesis that retardate-normal differences in discrimination learning derive only from variations in the probability of observing certain stimulus dimensions. After a problem has been learnt, all Ss are considered to be at about the same level in terms of their probability of observing the stimulus dimension relevant in that problem. Consequently, differences between Ss should be attenuated in successive problems which utilize the same relevant stimulus dimension. This prediction was, in fact, supported by the ID shift results obtained in Experiment 1A. This makes it all the more interesting that the opposite pattern of group differences emerged on the present task, even though the same _S_s were involved.

The divergence can be reconciled through a consideration of the structure of the tasks in each case. In Experiment 1A new cues were introduced at the point of shift, so that only the dimension remained constant between problems. Thus only dimensional transfer could occur in that situation. In the present experiment, however, both the dimensions and cues remained constant across problems. As a result, both dimensional and instrumental response transfer could occur. Moreover, these transfer effects were in opposite directions, with negative transfer stemming from the switch in cue values. The effects of the negative instrumental response transfer were apparently stronger in the retardates than in the normals. Taken together, the results of the two experiments suggest that retarded and normal children of similar MA only perform similarly in ID shifts which arrange for pure dimensional transfer. When instrumental response transfer is also a factor in the shift problem, retardates and normals are likely to perform differently. There would appear to be sufficient evidence consistent with the present findings to justify the rejection of Zeaman and House's view that retardate-normal differences in discrimination learning reflect differences only in the probability of observing certain stimulus dimensions.

Conclusions

The results indicated that the retarded children were no less able than their normal MA peers to learn to withhold responses to the negative cue in a discrimination task in which correct negative cue choices were rewarded. This suggests that moderately retarded children are not grossly deficient in simple behavioural control. Under appropriate conditions, they can acquire simple positive and negative response tendencies at least as easily as normals of similar MA. The classical conditioning evidence reported by Astrup *et al.* (1967) supports this interpretation.

In reversal learning the retarded group made significantly more errors than the normals. The circumstances under which this occurred supported the contention that cognitive rather than motivational factors underlie the retardates' extreme concept switching disability.

Experiment 3

Changing a Simple Response Stereotype

This experiment extended the investigation of retardate impairment in tasks involving the inhibition of previously established habits. Previous studies of the problem have used predominantly a concept switching paradigm, in which the shift stage of the discrimination learning task requires the S to learn a stimulus-response connection which is in direct competition with the association learnt in IL. The purpose of the present experiment was to determine if retarded children still appeared deficient in relation to normal MA controls when the shift phase involved only a change in response sequencing; that is, while the specific stimulus-response associations remained constant throughout the task.

Method

Subjects. With the exception of one retardate who was unavailable because of sickness, the Ss were identical to those used in Experiment 2. Thus there were

39 retardates and 40 normals.

Apparatus. The apparatus was the same as that used in Experiment 2.

Procedure. The stimuli (slides of blue or yellow squares) were alternated with pieces of non-transparent cardboard in the 80 slots of the projector magazine. The slides were arranged so that they would be presented to all *Ss* in the sequence shown in Table 16.

Table 16

Sequence of Stimulus Presentation in Experiment 3

Trial	Colour	Trial	Colour
1	yellow	21	yellow
2	blue	22	blue
3	yellow	23	yellow
4	blue	24	blue
5	yellow	25	yellow
6	blue	26	blue
7	yellow	27	blue
8	blue	28	blue
9	yellow	29	yellow
10	blue	30	blue
11	yellow	31	blue
12	blue	32	blue
13	yellow	33	yellow
14	blue	34	blue
15	yellow	35	blue
16	blue	36	blue
17	yellow	37	yellow
18	blue	38	blue
19	yellow	39	blue
20	blue	40	blue

The task was to press the button whenever the yellow stimulus was presented, and to refrain from pressing whenever the blue stimulus was presented. Thus the procedure required Ss to alternate between 'press' and 'not press' on Trials 1-26, while on Trials 27-40 a non-alternating sequence of responses was required.

The stimulus presentation time was one second (manually controlled) and the inter-stimulus interval 4 seconds (automatically controlled).

As Ss were brought individually to the experimental room they were told, "We have another game for you today which is a bit like the last one, and you should be able to earn a lot of money." Ss were allowed to inspect the shop before being tested.

In the task instructions Ss were told that they would see either a yellow or a blue colour each time, and that when it was yellow they had to press the button, but when it was blue they must not press it. This instruction was accompanied by a demonstration, and Ss were tested to ensure that they knew exactly what was required. Ss were informed that each time they were correct they would receive a cent, and they were encouraged to try to get it right every time.

For the yellow stimulus, reinforcement was delivered immediately S responded. For the blue stimulus, reinforcement was delivered at the end of the one-second stimulus interval if S had abstained from pressing. Verbal reward and punishment were not used.

After Trial 40, Ss were given a 3-minute rest period during which E assisted them to count their money. At the conclusion of the 3 minutes E said, "Let's have another go and see if you can get even more money." Ss were then re-instructed, given a further demonstration and test, and a repeat presentation of the 40 trials.

This second run completed the experiment. At its conclusion Ss were invited to spend their money at the shop.

Results

The errors made by each S on the two runs through the procedure were combined for each trial. The mean total errors for the two subject groups on Trials 1-26 and Trials 27-40 are shown in Table 17. It may be seen that the retardates made significantly more errors than the normals in both stages.

Table 17

Mean Errors and SDs on Trials 1-26 and 27-40

	Retardates		Normals			
	Mean	SD	Mean	SD	t	p
Trials 1-26	3.0	3.6	1.3	2.0	2.53	< .02
Trials 27-40	5.4	7.9	1.1	2.3	3.28	< .01

It may also be seen in Table 17 that the retardates averaged just over twice as many errors as the normals on Trials 1-26, but nearly five times as many on Trials 27-40. This suggests that the retardates were more prone to errors after the change in sequence than before. In order to evaluate the significance of this effect, analysis of covariance was used to examine the difference between the subject groups on Trials 27-40 after adjusting for differences on Trials 1-26. A summary of the analysis of covariance is presented in Table 18. The value of the F ratio was significant at the 6% level, suggesting that a substantial decrement occurred in the retardates' performance following the change in sequence.

Table 18

Summary of Analysis of Covariance for Adjusted Errors on Trials 27-40

Source of variation	Sums of squares	df	Mean square	F
Total	1177.56	77		
Within gps	1121.71	76	14.76	
Adjusted means	55.85	1	55.85	3.78*

* $p < .06$

Discussion

The inferior performance of the retardates on Trials 1-26 was unexpected. The task was very similar to the IL stage of Experiment 2, on which the retardates tended to do slightly better than the normals. Moreover, it was expected that the task instructions would be sufficient to eliminate virtually all errors from Trials 1-26. The only differences between the initial stages of the previous and present tasks were the order of stimulus presentation, the use of verbal reinforcement, and the stimulus presentation interval. Probably the last mentioned was the most likely source of the retardate-normal difference on Trials 1-26. The interval of one second may have been too short to allow the retardates to process adequately the information required by the task. A shorter stimulus interval than used in Experiment 2 was chosen, because it was considered that this would facilitate the alternation sequence to develop into a response stereotype.

The result of the covariance analysis provided a reasonable indication that the retardates were less able than the normals of comparable MA to shift from an established behavioural stereotype to a new response sequence. This finding is further evidence that retardates manifest a gross deficiency in discrimination tasks involving the suppression of established habits. It is consistent with the Experiment 2 reversal results. Together, the present data and the Experiment 2 reversal results lend support to interpretations which emphasize the rigidity of learning processes in the retarded, or which point to a gross deficit for retardates in inhibiting a previously acquired habit.

However, the results of the present experiment cannot be considered decisive for the following reasons. Firstly, the fact that the subject groups differed on Trials 1-26 suggests that some extraneous uncontrolled factor (perhaps related to perceptual processing) was influencing performance. It is quite possible that the same factor was the major cause of the group differences on Trials 27-40. Further research is needed to determine the nature of this factor, and to investigate the flexibility of response stereotypes in retardates and normals matched in initial acquisition. Secondly, the $\underline{F}$ ratio in the analysis of covariance was of only borderline significance. This allows two contradictory inferences to be drawn. It could be argued either that a rare chance event had occurred and the difference between the groups was really insignificant, or that the difference would have been greater had the retardates made fewer errors on Trials 1-26 and developed a stronger alternating habit to begin with.

Experiment 4

Free Operant Discrimination and Extinction

In order to exclude the approach-avoidance confounding which occurs in experimenter-paced simultaneous discriminations, Ross (1966) advocated the use of a free operant method to investigate the ability of retardates to inhibit responses to the negative cue in discrimination learning. To the writer's knowledge there has been no study reported in which normals and retardates of similar MA, in groups of reasonable size, have been compared in a free operant discrimination task. Moreover, only the study of Yaeger (reported by Ross, 1966) has been directly concerned with the question of an inhibition deficiency in the free operant performance of retardates. Of course in a way this is not surprising, as the use of concepts like 'inhibition' tends to be eschewed by operant experimenters. In Yaeger's experiment, in which the normal group was 20 months higher in mean MA than the retarded group, it was found that the subject groups did not differ in acquisition when the MA difference was partialled out statistically. However, the retardates were inferior to the normals in reversal, and made responses of greater amplitude than the normals. Both of these results could be construed as evidence for 'some kind' of inhibition deficiency in retardates. Disregarding the heuristic value of such an interpretation, the study suggests that there may be differences between the performance of retarded and normal Ss of similar MA in free operant discriminations.

A free operant study by Barrett (1965) examined the ability of 25 institutionalized retardates (IQ range 33 to 81, MA range 2-11 to 10-6) and two normal children (CAs 4 and 6 years) to discriminate between two stimulus lights and two response knobs. The lights alternated on and off at 60-second intervals, and Ss were reinforced on an FR10 schedule for operating the left manipulandum when the left light was on. No other stimulus-response pattern was reinforced. Only six retardates reached the level of discrimination attained by the two normal children. The other retarded Ss exhibited a variety of 'abnormal' behaviours. Some discriminated between the stimulus lights but failed to differentiate between the response knobs. Some showed the opposite pattern; response differentiation but not stimulus discrimination. The behaviour of others indicated successful discrimination and differentiation but excessive generalization. This was represented by pulling the left knob when the left light was on and the right knob when the right light was on, but not left knob for right light or right knob for left light. Still others (eight retardates) showed completely non-differential behaviour. That is, they pulled either knob equally often regardless of which light was on.

Barrett's procedure is unique in that it permits a more analytical approach to learning deficits than do many discrimination learning paradigms. As Barrett stated (1965, pp. 863-864), "Most discrimination tasks require the subject to respond to the 'correct' stimulus with the 'correct' response. Differentiation of responses is a prerequisite assumed to be within the child's repertory. Should the subject appear unable to tell the stimuli apart, he may be considered to have defective discrimination when his more basic problem, unmeasured by conventional designs, may be a current inability to tell responses apart." While a number of the retarded Ss in Barrett's study did not show a 'normal' decrement of responses in the presence of the negative cue, there were three different manifestations of this deficit: a failure to discriminate the stimuli (pulling the left knob during S^{D-}), overgeneralization (pulling the right knob during S^{D-}), and completely non-differential behaviour (pulling either knob during S^{D-}). Unfortunately, as only two normals were included in the study, firm conclusions from the data about the comparative performance of retarded and normal children in operant discrimination are precluded.

The present experiment used a modification of the Barrett (1965) and Barrett and Lindsley (1962) procedure to compare the free operant discrimination learning of retarded and normal children of similar MA. Whereas in Barrett's studies the stimuli had differed only in position (left or right), in the present case the stimuli differed in colour as well as position. Thus the task was a compound colour-position discrimination. Colour was introduced as a dimension so that the task would have compatibility with the tasks used in the previous experiments. The first purpose was to ascertain if the retardates were inferior to the normals in learning to inhibit responses to the negative cue (in this case the unreinforced cue), and if so whether the inhibitory deficit could be analyzed into the more specific components suggested by Barrett's study.

Acquisition was followed in the present experiment by a period of extinction. If retardates are deficient in inhibiting responses in the face of non-reinforcement, this should be clearly manifested during extinction. Denny (1964) considered that the existence of a general inhibitory deficiency in retardates was well supported by classical conditioning demonstrations of slow extinction in these Ss. Other reviewers, however, did not find the classical conditioning evidence quite so convincing (Astrup et al., 1967; Heal & Johnson, 1970). The only instrumental learning study to have compared retarded and normal children of similar MA in extinction (Johnson, 1966) did not find a difference between the groups on the criterion measure of response speed. Extinction performance has particular relevance to the present project, because it provides an indication of an S's ability to inhibit a previously established habit in circumstances where there is no additional new task to be learned (such as a reversal, for example). The second purpose of the experiment was to compare the subject groups in terms of the decrement in response frequency during extinction. The findings would subsequently be contrasted with reversal performance in Experiment 5.

Method

Subjects. The retarded child absent during Experiment 3 had returned to the group, while one normal child had left. As a result there were 40 retarded and 39 normal Ss. The mean MAs of these groups were, respectively, 69.2 months and 71.7 months.

Apparatus. The discriminanda (two lights approximately one inch in diameter) and manipulanda (two push buttons approximately one inch in diameter) were fixed to the sloping front of a small black box. The lights were centred 6 inches apart and 6 inches directly above the buttons. The left light and button were yellow, the right light and button were red. The circuit was such that only one light operated at a time, with the two alternating on and off at 30-second intervals.

Stimulus changes and responses on the buttons were recorded on a moving paper tape. The recording apparatus was housed in a wooden cubicle, in which E also sat. The cubicle had a one-way vision panel in the front of it, which allowed E to observe S from a distance of approximately 4 feet.

A device for dispensing cent coins into a plastic dish was placed on the left of the stimulus-response display panel. The stimulus-response display panel and coin dispenser are shown in Figure 4.

Procedure. 1. Acquisition. Acquisition was programmed so that pushing the left button while the left light was on led to reinforcement. All other stimulus-response configurations were on extinction.

As Ss were brought individually to the experimental room for their first session they were informed that there was a new game today, and that they should be able to earn a lot of money. They were allowed to spend a few minutes at the beginning of each session

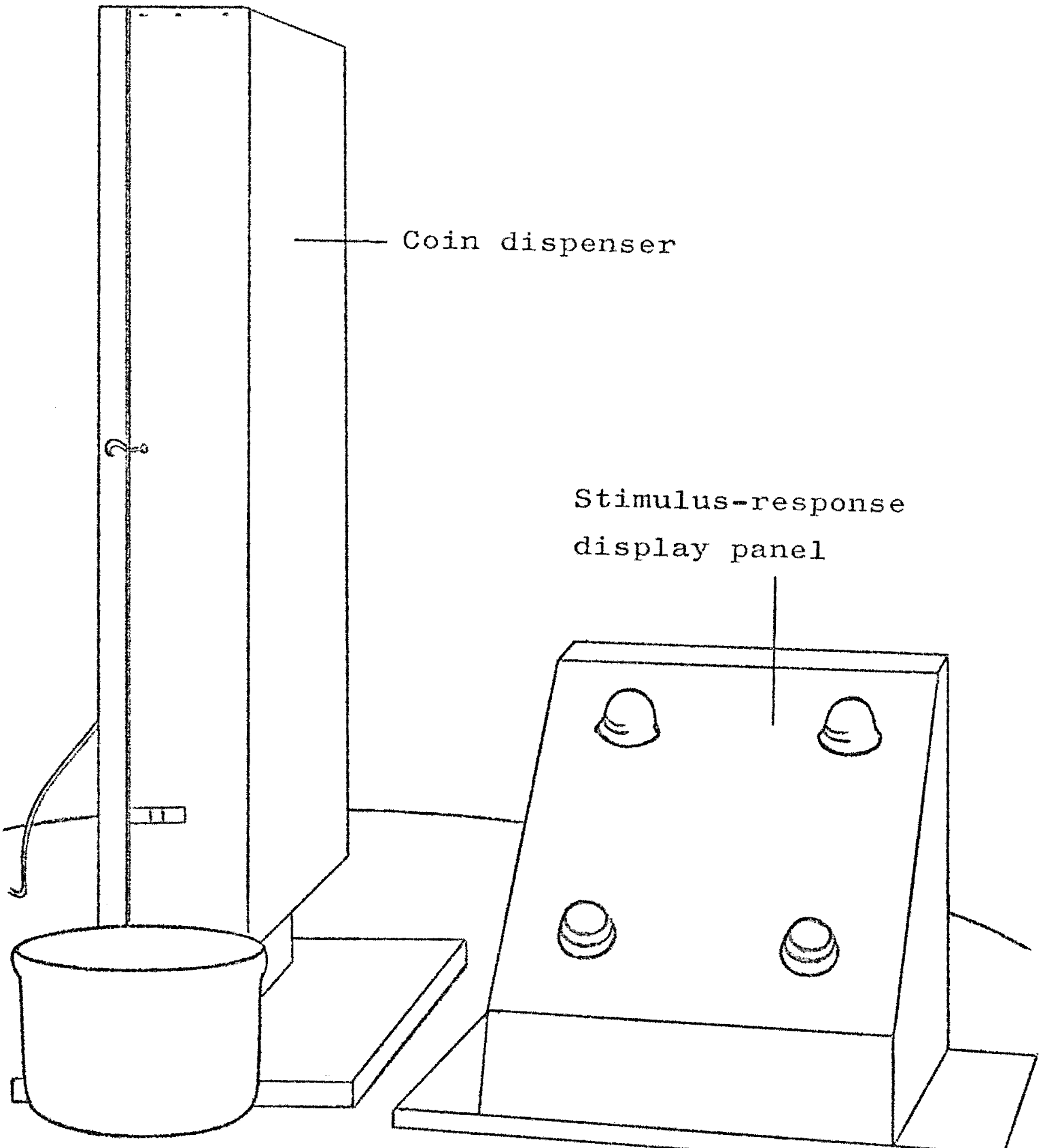

Fig. 4. Apparatus used in Experiment 4.

inspecting the items in the shop, before being taken to the other side of the room and seated in front of the display panel.

At the start of the first session Ss were given the following instructions. "You see there are two lights here (indicated by E) and two buttons here (indicated), and you can learn how to work the machine so that you get money. As soon as one of the lights comes on the machine is ready for you to start working."

E then retired to his cubicle and switched on the apparatus. Each session began with the presentation of the left stimulus light (S^D).

All Ss began on an FR1 schedule of reinforcement, and were gradually increased to FR10 at which they remained. Each S's individual performance provided the criteria for changes in schedule.

After 5 minutes any S who had not responded was told, "Get some money." If necessary this instruction was repeated in various more emphatic forms (e.g., "Go on, get some money") until S began responding.

Ss were given six 20-minute acquisition sessions. These were separated by intervals of from one to 2 weeks. At the start of the second and following sessions, *S*s who had shown a very low final rate in the previous session were told, "Last time you didn't get much money. You can get a lot more, so try to get more today." All other *S*s were simply asked, "Are you ready to get some more money?" before *E* switched on the apparatus.

During the second half of the third session, *S*s who had not reached a high enough response rate to be shifted to FR10 were given a demonstration of high rate responding (reinforced on FR10) by *E*. It was never necessary to give more than one such demonstration.

2. Extinction. After six acquisition periods *S*s were brought back for a seventh session of 32 minutes duration. For the first 12 minutes the procedure remained the same as in the previous sessions, but after 12 minutes no further reinforcement was delivered. The last 20 minutes constituted a period of extinction. At the start of this seventh session *S*s were asked, "Are you ready to get some more money?" before *E* switched on the apparatus. No further instructions were given during the session.

Results

1. Acquisition. Responses made on the left button while the left light was on were designated correct. All other responses were considered errors.

The performances of the two groups for the sixth acquisition session are summarized in Table 19. The

Table 19

Summary of Group Performances for the Sixth Acquisition Period

	Retardates (n=40)	Normals (n=39)	
Mean % of correct responses	83.5 (SD=19.8)	84.5 (SD=18.7)	t=0.23
% of Ss with 100% of responses correct	32.5 (n=13)	38.5 (n=15)	X^2=0.32
% of Ss with 90% of responses correct	57.5 (n=23)	59.0 (n=23)	X^2=0.02
Mean frequency of response	921.0 (SD=715.4)	753.7 (SD=375.0)	t=1.28

differences between the subject groups in mean percentage of correct responses and mean frequency of response over the 20-minute period were evaluated by *t* tests. Neither difference proved to be statistically significant. The differences between the groups in percentage of *S*s for whom 100% of responses were correct and percentage of *S*s for whom over 90% of responses were correct were evaluated by Chi-square. Again neither difference was significant. Within each group there was a wide variation in response frequency. For the retarded group the range in total responses for Session 6 varied from 118 to 2877, and for the normal group the range was 185 to 1847.

For those *S*s who did not attain the level of 90% correct responses during Session 6, the predominant error pattern in all but three cases was overgeneralization; i.e., pushing the right button while the right light was on. One retardate and one normal exhibited primarily a lack of discrimination (pushing left button while right light was on), while one retardate behaved in a completely non-differential fashion (pushing either button equally often regardless of which light was on).

2. Extinction. For the purposes of analysis performances during the seventh session were divided into four parts: (A) 2 minutes warm-up, (B) 10 minutes pre-extinction, (C) the first 10 minutes of extinction, and (D) the second 10 minutes of extinction. Extinction indexes for the first and second 10-minute periods of extinction were calculated by dividing the number of responses made during each of these periods by the number of responses made during the 10-minute pre-extinction period; i.e., C/B and D/B. The means of the extinction indexes for the two subject groups during the first and second 10-minute extinction periods are shown in Table 20. When evaluated by *t* tests, the differences between the groups were not statistically significant.

The means in Table 20 were derived from the raw data for all *S*s. A clearer indication of the effect of removal of reinforcement would be obtained from an examination of those *S*s who performed in a predominantly 'correct' fashion prior to extinction. These are the children for whom it can be said most confidently that the experimental manipulations were

Table 20

Mean Extinction Indexes and SDs for

Two 10-minute Periods of Extinction

	Retardates (n=40)		Normals (n=39)		
	Mean	SD	Mean	SD	t
First 10 minutes of extinction	.88	.41	.83	.32	.60
Second 10 minutes of extinction	.68	.48	.62	.40	.60

effective in controlling behaviour during acquisition. The mean extinction indexes for the 23 Ss in each group for whom over 90% of responses were correct during Session 6 are reported in Table 21. Again, t test comparisons indicated that the subject groups were not significantly different.

Within each group there was great variability during the extinction period. Some Ss ceased responding, while others showed a progressive increase in response rate. Of the Ss who were over 90% correct at the end of acquisition, (a) four retardates and seven normals gave up responding during extinction, and

Table 21

Mean Extinction Indexes for Ss who were over 90% Correct in Sixth Acquisition Period

	Retardates (n=23)	Normals (n=23)	t
Mean % of responses correct in Session 6	98.6	99.1	
Mean index for first 10 minutes of extinction	.80 (SD=.42)	.83 (SD=.37)	.25
Mean index for second 10 minutes of extinction	.65 (SD=.52)	.53 (SD=.44)	.84

(b) six retardates and four normals were responding at a higher rate at the end of extinction than during the pre-extinction period. A sharp drop in response frequency during extinction was not confined to Ss who had clearly been under strong stimulus control before extinction. Six retardates and five normals who had not attained the 90% correct level in acquisition, reduced their pre-extinction response rate by over 50% during the last 10 minutes of extinction.

Discussion

There was no indication that the retardates were inferior to the normals in any facet of acquisition. This is consistent with the IL results for Experiment 2. Together, the two sets of findings indicated that regardless of the reward contingencies associated with the withholding of responses in the presence of the negative cue, the moderately retarded children were no less able than their normal MA peers to develop inhibition of responses to the negative cue.

The results failed to confirm the implication of Barrett's (1965) study that retardates manifest a variety of acquisition deficits not found in young normals. Although the present procedure was a partial replication of Barrett's, and the retarded Ss in the two studies were probably fairly similar in regard to CA, MA, and IQ (but with a narrower range on these variables in the present sample), there were some major differences between the studies. Barrett used institutionalized retardates and only two normals, whereas in the present case non-institutionalized retardates were compared with a large group of normals. Either or both of these factors could have been responsible for the discrepancies in the outcomes. As indicated by Stevenson (1963), from comparisons between institutionalized retardates and non-institutionalized normals it is not possible to determine the contribution of retardation to performance deficits. Institutionalization may produce effects over and above the effect of retardation. The wide variability found amongst both groups in the present study makes it clear that group trends on tasks of this kind cannot be estimated reliably from the performances of only a few Ss.

The studies also differed in length. Barrett ran Ss for 60 minutes at a time until their performances showed stability over at least five consecutive sessions. In some instances this required over 30 hours of experimentation. Despite the desirability of this approach, limitations on time prevented its adoption in the present study. It is, of course, possible that subject group differences might have emerged if a more protracted investigation had been carried out. However, Barrett's report suggests that 2 hours should have allowed sufficient time for an indication of impending differences. Her two normal Ss had established predominantly 'correct' patterns by the end of the first session. Also, acquisition should have been accelerated to some extent in our task through the use of lower reinforcement ratios and prompting during the initial stages. Of course this latter influence means that the procedure was not strictly speaking 'free' operant throughout.

It is conceivable that the subject groups performed similarly in acquisition because they were by this stage of the project experienced in discrimination learning. Perhaps the retardates would have been found inferior to the normals had the experiment been placed earlier in the series. However, Barrett's results specifically implied that normal children quickly learn to respond to the task in a predominantly correct manner, whereas retardates are likely to show a variety of behavioural deficits. But in the present experiment over 40% of the Ss in each group failed to reach the 90% correct level during acquisition.

The absence of a retardate-normal difference in mean percentage of correct responses during acquisition supported the findings of Yaeger (reported by Ross, 1966). The data for frequency of response during acquisition provided a convincing demonstration that the retardates were at least as well motivated by the reinforcement system as were the normals.

Spradlin and Girardeau (1966) remarked that most studies of extinction with human Ss have investigated only the initial phases of extinction. Because of time limitations the present investigator was forced to perpetuate this situation. Within the restricted time available for extinction, there was no significant difference between the retarded and normal groups in reduction of response frequency. An implication is that the retardates experienced no more difficulty than the normals in inhibiting the performance of an established habit when reinforcement ceased. In both groups there was considerable individual variability in output during extinction, which was not related to performance efficiency prior to extinction.

Conclusions

There was no evidence of a deficit for the retarded children in either the acquisition or extinction phase of the task. As both phases involved inhibition of responses to unreinforced cues, there was no indication that moderately retarded children differ from normals of similar MA in their capacity to develop such inhibitory tendencies.

Experiment 5

Operant Reversal

Two explanations which have been advanced to account for the occurrence of a retardate deficit in reversal learning are cognitive rigidity, and an inability to inhibit previously acquired habits. The former conception was proposed many years ago (Kounin, 1941; Lewin, 1936), while the latter is a recent interpretation (Heal *et al*., 1966). To date these alternatives have not been explicitly pitted against each other (Heal & Johnson, 1970). The main purpose of the present experiment was to test the validity of the two interpretations.

A straight forward indication of an *S*'s ability to inhibit performance of a previously acquired habit is obtained during extinction, and it was demonstrated in Experiment 4 that the retardates did not differ from the normals in extinction. In the present experiment the same subject groups were compared in reversal learning on a task which was very similar to that used in Experiment 4. If the retardates proved to be inferior in learning the reversal (which was expected in view of their performances in Experiments 2 and 3), it would be erroneous to conclude that this was due to their inability to extinguish performance of the pre-reversal habit. The occurrence of a reversal deficit in the absence of an extinction deficit would vitiate the inhibitory deficiency interpretation and support the rigidity notion.

The present task was a simplification of the one used in Experiment 4. The two stimulus lights were retained but only one manipulandum was made available to the Ss. This change was incorporated to reduce the number of alternatives an S might have to explore during the reversal phase. It was considered desirable to keep the reversal task as simple as possible to prevent any chance of a 'floor effect' influencing performance.

Another question of interest in the experiment was to observe what effect eliminating one manipulandum would have on the behaviour of those Ss who were predominantly overgeneralizers in Experiment 4. If, as Barrett (1965) suggested, overgeneralization in the two stimulus-two manipulandum arrangement refers to a tendency to generalize from 'left light-left button (correct)' to 'push the button under the light' (which was incorrect), (or maybe in the present case to generalize from 'yellow light-yellow button' to 'push the button the same colour as the light'), then how would 'overgeneralizers' behave in a two stimulus-one manipulandum arrangement when the manipulandum is equidistant (and a different colour) from the stimuli? Presumably they should make less errors in this situation if Barrett's interpretation of the effect is correct.

The experiment also served a methodological function. As an adjunct to a free operant discrimination in which S^D and S^{D-} have been alternated on a fixed time basis, a reversal provides a check on the origin of stimulus control. If the switch in cue value initially produces a marked disruption in behaviour, it is implied that the experimenter-defined stimuli were exerting an effective controlling influence. The performance of the Ss in the present study would give an indication of the degree of stimulus control achieved with the apparatus.

Method

Subjects. There were 40 retardates and 37 normals, two normals having left the group since Experiment 4 was conducted.

Apparatus. The apparatus was the same as used in Experiment 4 except for one modification. The display panel contained only one response button, blue in colour, placed 6 inches below the stimulus lights and midway between them.

Procedure. Three sessions were held, with the first and second separated by between one and 2 weeks and the second and third given on consecutive days.

For the first session, of 20 minutes duration, the left light (yellow) was S^D and the right light (red) S^{D-}. Ss were reinforced on an FR10 schedule. The purpose of this session was to familiarize Ss with the one manipulandum situation. At the start of the session Ss were shown the display panel and told, "You see we have only one button now. Let's see how much money you can get today." E then retired to his cubicle and switched on the apparatus. This and the following sessions began with the presentation of the yellow stimulus.

The second session was of 32 minutes duration. No change in the procedure occurred at the start, but after 12 minutes the discrimination was reversed--i.e., the yellow stimulus became S^{D-} and the red stimulus S^{D}. For reversal, reinforcement began on FR1 for one reinforcement, was then shifted to FR3 for one reinforcement, to FR5 for one reinforcement, and finally to FR10 where it was fixed.

The reversal procedure (red stimulus as S^{D}) was continued throughout the third session of 30 minutes duration. At the start of Sessions 2 and 3 _S_s were asked, "Are you ready to get some more money?" No other comment was made by _E_.

At the conclusion of each session _S_s were invited to spend their money in the shop.

Results

The data for analysis come from Sessions 2 and 3. Session 2 was divided into a 2-minute warm-up period, 10 minutes pre-reversal, and 20 minutes reversal. Session 3 consisted of 30 minutes reversal.

Table 22

Percentages of Responses to S^D in 10 Minutes Pre-reversal and in Five 10-minute Periods After Reversal

	Retardates		Normals	
	Mean	SD	Mean	SD
10 minutes pre-reversal	87.3	17.6	86.9	17.6
1st 10 mins after reversal	37.2	31.9	38.7	29.4
2nd 10 mins after reversal	56.7	38.8	67.5	27.4
3rd 10 mins after reversal	62.4	34.5	78.4	19.8
4th 10 mins after reversal	66.6	35.9	86.5	17.4
5th 10 mins after reversal	67.7	37.4	87.0	17.4

The mean percentages of responses to S^D for the 10 minutes prior to reversal and for the five 10-minute periods after reversal are shown in Table 22. The difference between the subject groups before reversal is negligible, but it may be seen that after reversal the normals made a higher proportion of responses to the positive cue than did the retardates. Furthermore, in the last 10 minutes of reversal the normals were back to their pre-reversal level whereas the retardates were not.

As Bartlett's test suggested that there was marked heterogeneity of variance among the reversal percentages ($\underline{X}^2$=55.6; p < .001), the data were submitted to an arcsin transformation before being analyzed further. The results of an analysis of variance (unweighted means solution) on the transformed scores for the five reversal periods are summarized in Table 23. The between groups $\underline{F}$ was not quite significant at the 5% level.

Table 23

Summary of Analysis of Variance

for Five Reversal Periods

Source of variation	Sums of squares	df	Mean square	F
Between groups	11280.7	1	11280.7	3.62*
Within groups	233505.8	75	3113.4	
Total	244786.5	76		

*p < .10

In view of the fact that it was only during the first 10 minutes of reversal that the subject groups performed similarly, it was deemed to be acceptable to carry out a further analysis of variance on the last four reversal periods. This second analysis is summarized in Table 24. The resulting F indicated that the normals' performance was significantly superior to the retardates' during the last 40 minutes of reversal.

Table 24

Summary of Analysis of Variance

for Last Four Reversal Periods

Source of variation	Sums of squares	df	Mean square	F
Between groups	13352.1	1	13352.1	5.84*
Within groups	171350.2	75	2284.7	
Total	184702.3	76		

*p < .05

Discussion

The results demonstrated a deficit for the retardates relative to the normals in reversal learning. In view of the similarity of the groups in extinction in Experiment 4, it cannot be concluded that the retardates' reversal deficit arose from their inability to inhibit performance of the pre-reversal habit when it was no longer reinforced. Instead, it is suggested that the results were strongly indicative of a lack of flexibility in the learning processes of the retarded.

The groups did not differ in percentage of responses to S^D prior to reversal. This finding of a retardate-normal difference in reversal when it had been absent in acquisition parallels exactly the results of Experiment 2, and reflects the result of the covariance analysis in Experiment 3.

It is interesting to compare the mean percentage of responses to S^D in the pre-reversal period with the mean percentage of correct responses at the end of acquisition in Experiment 4 (Table 19). The very slight improvement in performance shown by both groups on the present task suggests that removing one manipulandum had little overall effect on the difficulty of the discrimination. There were, nevertheless, seven _S_s (four retardates and three normals) whose performance rose from below the 90% correct level in Experiment 4 to above this level in acquisition of the present task. The range of improvement among these _S_s varied from 13.9% to 49.9%. In addition, three more _S_s (two retardates and one normal) increased their percentage of correct responses by over 10%, although they were still below the 90% criterion. All of these 10 _S_s had been predominantly overgeneralizers in Experiment 4. However, two overgeneralizers (one retardate and one normal) reduced their percentage of correct responses by over 10% on the present task, and 16 overgeneralizers (nine retardates and seven normals) did not change their level to any marked extent over the two situations. This variability among overgeneralizers in performance in the one manipulandum situation suggests that overgeneralization was not just the unitary behavioural effect (a tendency to 'press the button under the light', or maybe with the present apparatus to 'press the button the same colour as the light') which Barrett had implied.

In the first 10 minutes of reversal, both subject groups showed a sharp drop from their pre-reversal level in mean percentage of correct responses. This effect is evidence that the experimenter-defined stimuli were effective sources of behavioural control. Ideally, of course, a reliable assessment of stimulus control is based upon the execution of more than one reversal. However, the reversal patterns exhibited by the groups in the present case justify confidence in attributing control to the stimulus lights. It is unlikely that the sharp drop followed by a gradual but differential rise would have occurred otherwise, particularly as the differential reversal behaviour of the groups corresponding to other data obtained from the same Ss. It seems reasonable to go further, and suggest that the lights would also have been effective stimuli in Experiment 4.

Overview

Experiments 2, 4, and 5 showed that the moderately retarded children were not deficient in comparison to the normals of similar MA in learning to withhold responses to the negative cue in discrimination learning. This was true regardless of whether the development of inhibitory tendencies was rewarded or not.

Experiments 2, 3, and 5 indicated a major deficit for the retarded Ss in tasks which involved the suppression of a previously established habit. When required to reverse an S-R association and alter a response stereotype, the retardates performed much more poorly than their normal MA counterparts.

There was no suggestion that the inferiority of the retardates in these shift situations resulted from inadequate motivation. On the contrary, it seemed that the source of the deficits was located in some crucial learning process. Together, Experiments 4 and 5 implied that this process had to do with the flexibility rather than the inhibition of established habits.

Chapter 5

Consistency and Variability in Retardate Performance

The tasks used in Experiments 1B, 2, 3, and 5 were similar in that they arranged for some degree of negative transfer to occur from IL to SL. This was accomplished by switching the relevant and irrelevant dimensions in Experiment 1B, by reversing the positive and negative cues in Experiments 2 and 5, and by changing the response sequence requirement in Experiment 3. For all of these tasks there was evidence that the retarded group experienced particular difficulty in coping with the effects of negative transfer in SL. This was most obvious in Experiments 2 and 5, where the retardates made significantly more reversal errors than the normals after the groups had not differed in IL. Although the groups did differ in IL in Experiment 3, the retardates' inferiority in SL was still apparent after their IL deficit had been partialled out. For the ED shift of Experiment 1B the retardates' mean error score was higher than the normals', but not significantly so. Nevertheless, the retardates' inability to handle negative dimensional transfer was indicated by the fact that they found the ED shift significantly more difficult than the positive transfer ID shift of Experiment 1A, whereas the normals did not. The deficiencies exhibited by the retardates in these tasks demonstrated their extreme rigidity or inflexibility.

The consistency with which the retarded group as a whole displayed this excessively rigid behaviour raises the following questions. To what extent did the individual retarded Ss vary in performance on the switching tasks? Was a lack of flexibility in switching to new learning responsible for the gross deficiency of many retarded Ss in Experiment 1A IL? Was the tendency towards rigidity associated with verbal disability in the retarded group? Each of these questions will be dealt with in turn.

There are two issues of relevance to the first question; inter-individual variability and intra-individual variability. An analysis of inter-subject variability is presented in Table 25, which contains

Table 25

SDs and Ranges of Errors in IL and SL for Experiments 1B, 2, 3, and 5

	IL		SL	
	R	N	R	N
Experiment 1B				
SD	11.6	12.0	14.3	12.4
Range	0-95	0-60	0-40	0-39
Experiment 2				
SD	9.5	9.1	12.0	4.7
Range	0-47	0-39	1-42	1-25
Experiment 3				
SD	3.6	2.0	7.9	2.3
Range	0-13	0-11	0-25	0-10
Experiment 5				
SD	17.6	17.6	37.4	17.4
Range	0-49.2%	0-47.9%	0-100%	0-47.4%

Note: R=retarded group, N=normal group. For Experiment 5; IL=10-minute pre-reversal period, SL=fifth 10-minute reversal period, ranges shown as percentage responses to S^{D-}.

the standard deviations and ranges of errors in Experiments 1B, 2, 3, and 5. It is evident that while there was often little difference in variability between the subject groups in IL, the retardates generally showed much wider variability in SL, both in relation to their own IL performance and in relation to the normals' SL performance. But it may also be noted that the lower end of the range was always the same for the two subject groups, and in fact in each SL task approximately 50% of the retarded Ss performed no differently from the majority of normals. Thus while excessive rigidity characterized the retarded group as a whole, the individual retarded Ss did not always exhibit less flexibility than the normals.

To examine the retardates' intra-individual variability in rigidity, the performances of the retarded Ss in the SL stages of Experiments 1B, 2, 3, and 5 were correlated. The data used for computing the correlation coefficients were residual Z scores for errors in SL, obtained by the formula:

$$Z_{residual} = Z_1 - r_{12}Z_2$$

(where Z_1= error Z score for SL; Z_2= error Z score for IL;

and $\underline{r}_{12}$= product moment correlation between $\underline{Z}_1$ and $\underline{Z}_2$). This transformation yielded scores for SL which were independent of differences in habit acquisition.

The resulting product moment correlation coefficients are reported in Table 26. Although low, the correlations among Experiments 1B, 2, and 5 were significantly larger than zero at the 5% level. The three small coefficients involving Experiment 3 were not statistically significant. This pattern in the data suggests that two different abilities were being sampled; one common to Experiments 1B, 2, and 5, and another specific to Experiment 3. An implication is

Table 26

Correlation Coefficients for Retardate SL Errors in Experiments 1B, 2, 3, and 5 Derived from $\underline{Z}$ Residuals

Experiment	2	3	5
1B	.348* (n=39)	.044 (n=38)	.376* (n=40)
2		.114 (n=38)	.318* (n=39)
3			.050 (n=38)

* $p < .05$

that two kinds of rigidity occur amongst retardates; response habit rigidity (Experiment 3) and conceptual rigidity (Experiments 1B, 2, and 5). Of course this assumes that the retardates' behaviour in the shift phase of Experiment 3 was indicative of a defect in flexibility, but an alternative possibility must be recognized. The fact that the retardates were inferior to the normals in IL of Experiment 3, but not in IL of Experiments 1B, 2, and 5, indicates that there was a fundamental difference between the tasks in each case. Furthermore, because they made numerous errors, the retardates may not have established a very strong alternating habit in IL of Experiment 3. Consequently in SL they may not have needed to be very flexible in order to shift from the IL habit. So it is conceivable that the pattern in the correlation matrix reflects the operation of a rigidity factor in Experiments 1B, 2, and 5, and a non-rigidity factor in Experiment 3.

While it was evident that some degree of commonality existed among Experiments 1B, 2, and 5, the magnitude of the correlation coefficients was low suggesting that there was considerable within-subject variability in these three measures of rigidity. This is verified by an examination of the retardates' individual performances in SL. When the Z residual SL error scores for each of the three experiments were split at the third quartile, a total of 21 Ss (50%) fell in the fourth quarter at least once. However, only three Ss were in the fourth quarter for all three tasks. Six Ss were above the third quartile in two tasks, and the remaining 12 Ss in only one task. This individual inconsistency in the manifestation of deficits might be a feature of retardate behaviour. Baumeister (1968), in an analysis of behavioural inadequacy and variability of performance, argued that unreliability is itself a reliable phenomenon amongst retardates.

The second question posed at the beginning of the chapter asked whether an inability to change previously established habits (i.e., inflexibility) could have been responsible for the gross deficiency of a number of retarded Ss (and consequently the group as a whole) in the IL phase of Experiment 1A. Several investigators (e.g., Denny, 1964; Lobb, 1966; Zeaman & House, 1963) have suggested that retardates are inclined to adopt primitive strategies, such as position preferences, when faced with two-choice simultaneous discrimination problems. If this is the case, then an inability to overcome such tendencies (when they are irrelevant to task solution) would adversely affect an Ss performance in acquisition.

To assess the question, the retarded group was subdivided into the fast and slow learners of Experiment 1A IL. Fast learners (NT) were defined as those Ss who did not require special training to reach criterion, while slow learners (T) were those Ss to whom varying amounts of special training were given. The means and standard deviations of Z residual errors for T and NT in SL of Experiments 1B, 2, 3, and 5 are presented in Table 27. To determine whether these four measures of flexibility discriminated, either together or separately, between T and NT, a discriminant function analysis was carried out. This analysis showed that neither an optimal composite of the four measures (F=1.13) nor any measure separately (Fs shown in Table 27) discriminated significantly at the 5% level between the subgroups. Thus the evidence did not

Table 27

Means and SDs of *Z* Residual Errors in SL of Experiments 1B, 2, 3, and 5 for Retarded *S*s Differentiated According to their Need for Special Training in Experiment 1A IL

		Expt 1B		Expt 2		Expt 3		Expt 5	
Group	*N*+	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
T	20	45.0	10.1	27.2	9.1	12.4	7.4	38.9	9.0
NT	18	41.5	8.5	22.7	7.6	10.6	5.0	41.0	10.3
F ratio		1.70		2.60		0.81		0.63	

+ Complete data were available for 38 *S*s.

indicate that flexibility (in the sense of facility in switching to competing habits) was a significant determinant of retardate learning ability in Experiment 1A IL.

The third question raised at the beginning of the chapter concerned the relationship between verbal deficiency (as measured by the ITPA) and rigidity in the retarded group. Luria (1963), when discussing the role of verbal processes in the regulation of behaviour, indicated that connections formed in the verbal system are normally more labile than connections formed in the motor system. This suggests that flexibility of motor habits would be enhanced when behaviour is regulated by a mature verbal system; and conversely that defective verbal development would likely be associated with reduced flexibility.

The product moment correlation coefficients for the retarded group between ITPA total LA (in Z score form) and Z residual errors in SL of Experiments 1B, 2, 3, and 5 are reported in Table 28. While the negative direction of the coefficients is consistent with the view that verbal immaturity is related to inflexibility of motor habits, all coefficients are low, and only that for Experiment 1B is significantly larger than zero ($p < .01$). The overall implication of the data is that there was no substantial relationship between verbal ability and flexibility in the retarded group.

Table 28

Correlations for Retarded Group between ITPA Total LA and Z Residual Errors in SL of Experiments 1B, 2, 3, and 5

Experiment	1B	-.419*	(n=41)
..	2	-.120	(n=39)
..	3	-.161	(n=38)
..	5	-.205	(n=40)

* $p < .01$

Chapter 6

Summary and Conclusions

The present project was undertaken primarily to investigate the extent and nature of basic learning deficits in mentally retarded children. To achieve this, the performances of moderately retarded and normal children of similar MA (mean MA of retarded group 69.5 months, and of normal group 71.8 months) were examined in a number of discrimination learning tasks and on the ITPA. Comparisons between the two subject groups provided an indication of the extent of retardate deficiencies (i.e., whether they were inferior to their normal MA peers), while within group analyses enabled alternative conceptions about the nature of learning deficits to be studied. Certain aspects of the data also had significance for the wider context of general psychological theory concerning the processes involved in discrimination learning. To maximize motivation in all Ss (and eliminate inadequate motivation as a possible explanation for retardate learning deficiencies), a token economy system of reinforcement was employed in all the discrimination tasks.

The main issues taken up had to do with mediation and inhibition deficits in retardate discrimination learning. In the case of mediation, two experiments (Experiments 1A and 1B) were carried out which tested nine hypotheses derived from attention (Zeaman & House, 1963) and verbal mediation (Kendler & Kendler, 1962; Luria, 1961) theories of discrimination learning and retardate behaviour. The task in each experiment was a two-choice simultaneous discrimination learning problem, with colour and form as the two variable-within-trials dimensions. In Experiment 1A an ID shift followed IL, while in Experiment 1B an ED shift followed IL. A total change of cues occurred for the SL stages. A distinction was made between mediators, non-mediators, and dimensional preferers on the basis of the performances of the Ss in the two experiments, and the ITPA was used to measure the verbal development of mediators and non-mediators.

Consistent with predictions derived from attention theory (Hypotheses 1 and 2), but contrary to those derived from verbal mediation theory (Hypotheses 4 and 5), it was found that (a) the retarded group made significantly more errors than the normals in IL of Experiment 1A but not in IDSL, and (b) both subject groups tended to make more errors in EDSL than in IDSL. However, the data did not provide completely unequivocal support for attention theory. Firstly, the retardates' IL deficit appeared only in Experiment 1A (form relevant). In IL of Experiment 1B (colour relevant) they were not inferior to the normals. This implied either that the retardates' initial attention deficit was confined only to the form dimension and not to colour, or that their low initial probability of attending to the relevant dimension was a transitory defect readily ameliorated by experience. Secondly, while both subject groups tended to make more errors in EDSL than in IDSL, this effect was displayed to a significant degree only by the retardates. This finding could be accounted for in terms of two non-attention theory hypotheses; (a) the verbal mediation hypothesis that children in the MA range tested are in a transitional stage of mediational development, and (b) the notion that retarded children are particularly defective in their ability to inhibit previously established habits.

Although it appeared to be quite valid to distinguish between mediators, non-mediators, and dimensional preferers on the basis of Ss' performances in the discrimination tasks (a further indication that children in the MA range tested are in a transitional stage of mediational development), the hypothesis derived from verbal mediation theory predicting a higher proportion of non-mediators in the retarded group than in the normal group (Hypothesis 3) was not confirmed, even though the retardates were significantly inferior to the normals in verbal development (Hypothesis 6).

While the data based on the total subject sample were in line with the hypothesis predicting superior verbal development in mediators than non-mediators (Hypothesis 8), it was considered that the results had to be interpreted cautiously in view of the large subject group differences in the effect. It was only in the retarded group that mediators were, in fact, superior to non-mediators in verbal development. In the normal group the trend was in the opposite direction, although not significantly so. As the hypothesis in question is at the core of verbal mediation theory, the failure to find the predicted effect in the normal group was strongly antithetical to the verbal mediation position.

Because of the conceptual similarity of certain aspects of the ITPA model to verbal mediation theory, it was deduced that the retardates' verbal impairment would be most apparent on the representational level subtests of the ITPA (Hypothesis 7), and that the ITPA superiority of mediators over non-mediators would be manifested primarily on the representational level subtests (Hypothesis 9). Neither hypothesis was supported by the data.

At the conclusion of Experiment 1A Ss were required to give a verbal account of their learning. Verbal mediation theorists have often used this technique as a guide to the level of verbal development of Ss. The data obtained, however, suggested that the technique is relatively insensitive, as it failed to distinguish significantly between the retarded and normal groups. The ITPA, on the other hand, had shown the retardates to be markedly inferior to the normals in verbal development.

Four experiments (Experiments 2, 3, 4, and 5) were carried out to investigate the extent and nature of inhibition deficits in retardate discrimination learning. Each used a successive method of stimulus presentation, enabling responding to the positive and negative cues to be measured independently. The task in Experiment 2 was a simple colour discrimination, and Ss had to learn either to respond (push a button) or not respond on each trial. IL was followed by RL. A novel aspect of the procedure was the delivery of a reward for correct avoidance as well as for correct approach behaviour. This prevented approach and avoidance tendencies from being confounded with a reinforcement differential.

The purposes of the experiment were (a) to examine the ability of retarded and normal children to learn to withhold responses to the negative cue under conditions in which all correct choices were rewarded, and (b) to compare the performance of the subject groups in reversal learning. The results indicated that the retardates were no less able than the normals to withhold responses to the negative cue when rewarded for doing so. This suggested that moderately retarded children are not grossly deficient in simple behavioural control. In reversal learning the retardates were significantly inferior to the normals. On the assumption that the token economy system of reinforcement would have controlled motivation in the two subject groups, it was concluded that the reversal results were in line with the contention that cognitive rather than motivational factors underlie the retardates' extreme deficiency in concept switching tasks.

Experiment 3 followed a procedure similar to that used in Experiment 2, to study the ability of Ss to alter a simple response stereotype. After being given practice in the establishment of a single alternation response habit (alternating between press and not press on successive trials), Ss were required to switch to a non-alternating response sequence. The purpose was to compare the ability of the subject groups to handle this response-sequence shift. Unfortunately the clarity of the findings was marred by an unexpected deficiency of the retardates in developing the single alternation habit. This necessitated the use of analysis of covariance for comparing the performance of the subject groups in the shift phase. The result of the covariance analysis suggested, at a borderline level of significance, that the retardates were grossly deficient in the response-sequence shift.

A free operant methodology was employed in Experiment 4 to investigate acquisition and extinction of button pressing in response to discriminative stimuli which differed in both colour and position. The experiment was undertaken partly to check the generality of a previous study, which had suggested that retarded children exhibit a variety of acquisition deficits in discrimination learning which are more specific in nature than an inability to inhibit responses to the negative cue (in this case the unreinforced cue). In addition, an extinction phase was included to study the ability of Ss to inhibit a previously established habit when reinforcement ceased. The retarded group was not found to differ from the normal group in either the acquisition or extinction phase of the task. Thus there was no indication that the retardates experienced greater difficulty than the normals in inhibiting behaviour in the face of non-reinforcement.

In Experiment 5 the Ss were required to relearn and then reverse the colour-position discrimination of Experiment 4. The main purpose was to compare reversal learning with the previous extinction performance in order to determine whether (a) an inability to inhibit established habits, or (b) a lack of flexibility of learning processes, was responsible for defects in reversal learning. It had already been demonstrated in Experiment 4 that the subject groups were similar in ability to inhibit an established habit in the face of non-reinforcement. In Experiment 5 the retardates were found to be significantly inferior to the normals in reversal learning. These results supported the notion that cognitive rigidity is reflected in retardate deficits in reversal learning.

Taken together, the experiments concerned with inhibition showed that the retarded children were not deficient relative to the normals of similar MA in learning to withhold responses to the negative cue in discrimination tasks. But a major deficit for the retarded group occurred in those tasks which involved the suppression of established habits (the reversal and response-sequence shifts). It seemed that the deficits in these tasks were indicative of gross inflexibility in retardate learning processes.

Analysis of within-group performances on the concept and habit switching tasks showed a considerably greater degree of inter-individual variability amongst the retardates than amongst the normals. While excessive rigidity was characteristic of the retarded group as a whole on all of the relevant tasks, in each task there were always a number of retarded Ss (approximately 50%) who exhibited no less flexibility than the majority of normals. Further analysis revealed that there was also considerable intra-individual variability in the retardates' switching behaviour. It was not the case that the same individuals were always responsible for the deficits exhibited by the group as a whole. Nevertheless, there was a significant degree of inter-relation among the three tasks involving concept switching (Experiments 1B, 2, and 5), indicating that a common rigidity factor was sampled by these tasks. It seemed that a different rigidity factor (or perhaps a non-rigidity factor) was measured in the response-sequence shift (Experiment 3).

Although the retardates were inferior to the normals in IL of Experiment 1A and in verbal development as well as in the measures of flexibility, the deficits occurring in the former two situations appeared to bear no substantial relationship to inflexibility.

Overall, the outstanding feature in the research was the pervasive indication of rigidity in the retarded group. While this finding was not new it was very timely. During the last decade the rigidity characterization of retardate behaviour has to a large extent been discredited by the work of Zigler and his associates (e.g., Zigler, 1966), who proposed as an alternative that motivational factors rather than cognitive rigidity were responsible for retardates appearing deficient in relation to their normal MA peers in concept switching and similar tasks. But recently the viability of the rigidity construct has been revived (Butterfield & McIntyre, 1969; Heal & Johnson, 1970). The present results are a strong endorsement of Heal and Johnson's plea for the rigidity hypothesis to be re-applied to the study of the mentally retarded. It would seem that the most vital area for re-application is in remedial education, where urgent attempts should be made to devise programs for increasing the flexibility of retardate behaviour. The work of Sidman and Stoddard (1966), who used a fading technique to teach mentally retarded children to learn and then reverse a circle-ellipse discrimination without errors, offers a promising starting point for research in this area.

Zigler's objection to the cognitive rigidity interpretation of retardate inferiority in switching tasks was actually confined to the case of familial retardates, whom he considered to be simply dull normals who pass through the same stages of intellectual development (but at a slower rate and with a lower upper limit) as brighter normals. By matching familial retardates and normals in MA one would therefore be comparing groups of equivalent intellectual status, and any performance differences found would have to be attributed to non-cognitive factors (apart from variations due to unreliability or incompleteness of the matching measure). Zigler stated that children in whom mental retardation had its origin in a biological disturbance were non-normals, who could possibly manifest as many different kinds of abnormal cognitive disabilities as there are different biological causes of mental retardation.

As no attempt was made to take account of etiological differences in the present retarded sample, it could be argued that the results were not necessarily in conflict with Zigler's position because perhaps all Ss who displayed extreme rigidity were biologically impaired. This possibility cannot be denied, and the same objection could be raised against most of the studies cited by Heal and Johnson (1970) in support of the rigidity conception. But there are a number of problems and disadvantages associated with maintaining this kind of stance. Firstly, performance differences between etiological subgroups have seldom been found in research (Ellis, 1969). Secondly, it is doubtful if a clear-cut distinction between biological and cultural-familial causes of mental retardation can be upheld in practice. Thirdly, insisting upon dichotomizing the mentally retarded on the basis of presumed etiologies would appear to have little or no relevance to the really crucial activities of identifying and modifying behavioural disabilities. (This point was well argued by Leland, 1969.) In the present research the subject groups exhibited very similar performances in many respects, but whenever a change of set was required the retardates showed evidence of a deficit. To insist that this deficit must be restricted to a particular etiological group, so that future diagnosis and treatment of the disorder would be based upon the prescriptions of an etiological classification, would seem to be a futile position to adopt.

The fact that the retardates displayed a high degree of variability in the measures of flexibility does not diminish the significance which the rigidity notion has for retardate behaviour. While it is not being suggested that rigid behaviour is the fundamental 'big deficit' of mental retardation, it seems that a large proportion of children in the moderately retarded range are liable to exhibit this characteristic to a marked extent, even when compared to normals at a similar level of general intellectual development. It is quite probable that had more severely retarded Ss been used, or had the normal group been matched in CA, even more conspicuous retardate deficits in flexibility would have been observed. Intra-individual variability in performance is a common feature of behavioural abnormalities. This is the case not only for mental retardates (Baumeister, 1968) but for the psychiatric population in general (Sidman, 1962). Perhaps if there is any characteristic common among the psychiatric population, it is the inability to maintain a consistent level of performance.

The deficiency exhibited by the retardates in the two reversal problems points to an inadequacy in the Zeaman and House (1963) theory of discrimination learning. These investigators claimed that the relationship of intelligence to discrimination learning pertained only to the initial acquisition of the relevant attentional response, and not to the acquisition (and presumably also extinction) of instrumental choice responses. Consequently the nature of the discrimination learning deficit in retardates was construed only as a deficit in initial attention to the relevant dimension. But to accommodate a retardate reversal deficit in the absence of an IL deficit it seems that Zeaman and House would have to shift their emphasis to the instrumental learning stage, and give different parameter values for instrumental response acquisition and/or extinction in retardates and normals. The findings suggested that an attentional deficit was of only minor importance in the present retarded sample. Either it was restricted to a specific disability in initial attention to form (Experiment 1A IL) but not colour (IL stages of Experiments 1B and 2) or colour combined with position (Experiments 4 and 5), or it was a transitory phenomenon which was ameliorated by the experiemce gained in Experiment 1A.

It would not seem reasonable to ascribe the retardates' inferiority in IL of Experiment 3 to their low probability of observing the colour dimension, because in the other colour problems they showed no sign at all of an IL disability. As was stated previously, the deficit was possibly due to a processing defect in the retardates which became apparent when the stimulus presentation time was reduced to one second. Gerjuoy and Winters (1968) also reported evidence indicating slower processing of information in retardates than in normals, when stimulus exposure time was reduced from an unlimited period to 0.8 seconds in a size judging task. In view of these findings, further work should be carried out to determine the precise limits imposed on retardate learning by a processing defect.

Apart from a few notable exceptions (e.g., Furth & Milgram, 1965), Western investigators in the field of mental retardation have been inclined either to accept unquestionably or ignore the Russian work stressing the role of verbal deficits in retardate learning disorders. But because of differences in the concept of mental retardation and in research methodologies and techniques, it is important that the implications of the Russian work be examined in a Western context. A major implication of Luria's work is that retardates are handicapped in conceptual operations because of severe defects in verbal system functioning. But this was not substantiated in the present research. The retardates were not found to be mediationally deficient in comparison to the normals, despite being significantly impaired in verbal development. This finding raises questions about the generality of Luria's theory, which obviously needs to be examined more extensively before being adopted by clinicians or educators. Two issues in particular which require further study are (a) the conceptual level (if any) at which the retardates' verbal impairment does become a limiting factor in performance, and (b) a delineation of just what the consequences are of the gross verbal disability which retardates undoubtedly have. The somewhat paradoxical finding that within the retarded group the non-mediators were inferior to the mediators in verbal development, suggests that verbal factors may have more relevance to the conceptual behaviour of retardates than to that of normals.

A major segment of the project was devoted to the question of whether retardates are less able than their normal MA peers to inhibit responses to the negative cue in discrimination learning. Heal and Johnson (1970) stated that the most troublesome result for the general inhibition deficiency notion of retardate performance, has been the failure to find consistently that retardates are grossly deficient in learning to withhold responses to the negative cue. Inconsistency in this regard is not really surprising, as rarely have investigations concerned with inhibition of responses to the negative cue in instrumental discrimination learning incorporated a sufficient methodology. The present investigations appear to be the most comprehensive yet conducted into the matter, as errors of commission and omission were recorded separately, negative cue learning was examined in relation to both reward and non-reward for correct behaviour, and both acquisition and extinction trials were included. The fact that no differences were observed between the subject groups on any of the relevant measures, is convincing evidence that defective inhibition of responses to the negative cue is not a major source of deficiency for moderately retarded children in instrumental discrimination learning.

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