SOME FACTORS AFFECTING DISCRIMINATION LEARNING IN YOUNG CHILDREN

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by

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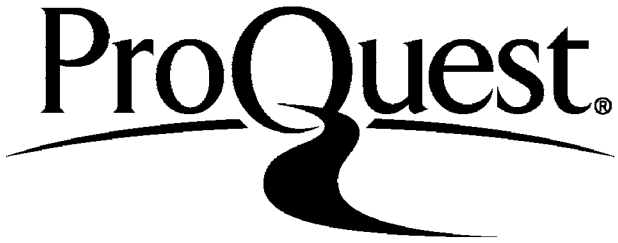

Abstract

An experiment was designed to test the effects of certain factors on the discrimination learning and shift performance of young children. Subjects were selected between the ages of $5\frac{1}{2}$ and $6\frac{1}{2}$ since it has been observed that at about that age, reversal and nonreversal shifts in discrimination are executed equally readily. Five dichotomous variables were controlled: intelligence, sex, social group, type of shift, and reward condition.

Subjects were assigned on their performance of the childrens' Progressive Matrices, to high or normal IQ groups. Males and females were separately grouped. Social group was determined by school attendance: two schools in middle class residential districts, and two in working class areas were visited. Children were allocated at random to shift and reward conditions. After initial training, half the children were rewarded for performing a reversal or intradimensional shift, the other half, a nonreversal or extradimentional shift. Half of the subjects received material incentives: sweets or trinkets for correct responses, and half, nonmaterial rewards: bell tinkles or light flashes.

The performance of 128 children was examined by five way analyses of variance. The variables' effects were minimal during initial training, but in the discrimination

shifts, interesting effects emerged. The group as a whole performed both shifts with relative ease, but middle class children performed reversal shifts better than nonreversal ones while working class children performed nonreversal shifts best. Reward effects interacted with intelligence: high IQ subjects performed best for material incentives. Girls generally performed better than boys, although the effects of sex interacted with both IQ and social group membership. A strong relation appeared between verbal facility as measured by the WISC Vocabulary and shift performance. A covariance analysis, by equalizing the impact of fluency, reduced the variability within groups, and accentuated the previously observed effects. A reward choice technique produced evidence of a developing preference for larger, delayed over smaller, immediate rewards in middle class children.

The results of this study indicate that the factors selected for study here do affect the discrimination learning of six year olds.

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Introduction: I

Reversal and nonreversal shift learning

The heartening discovery that laboratory rats and college students perform somewhat differently in certain experimental situations has attracted much sober consideration in the current American psychological research literature. The task in which differences have been observed is the discrimination learning and transfer paradigm involving reversal and nonreversal shifts. This type of learning problem involves the consecutive presentation of pairs of stimuli which differ on several dimensions. After a certain criterion of correct responses to one aspect of one dimension is attained, another discrimination is elicited: the same stimuli are used, but a shift in response is expected. The reversal shift, or intradimensional shift as it is sometimes called, involves the subject's response to the same dimension as before but to another aspect of that dimension. In the nonreversal or extradimensional shift condition, the subject is required to respond to an aspect of a previously irrelevant dimension. For example, if a subject is shown stimuli which differ simultaneously in brightness (black and white) and size (large and small), and if he is initially rewarded for responding to black, regardless of size, a reversal shift would consist of his

learning to respond to white; learning to respond to large or small would be a nonreversal shift. One variation of this sort of design is represented in Figure A.

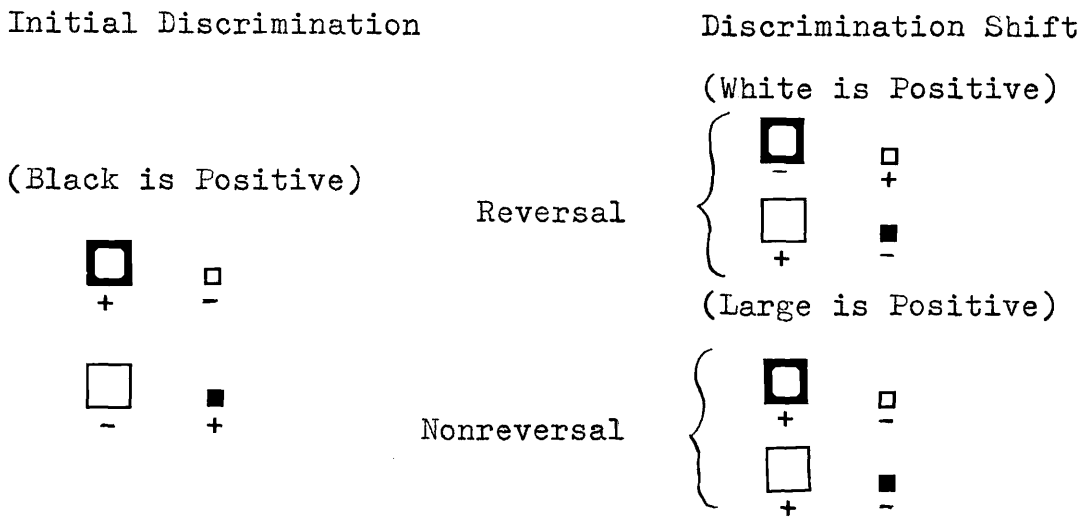


Figure A. Representation of stimulus presentations.

Shift learning in the context of behavioristically oriented experiments

A sketch of the history of the use of this experimental task will allow us later to make comparative statements concerning the performance of the subjects in the present study. It might be wise to stress that the major purpose of the present study was not to test the adequacy of the various theories which have been proposed to explain the phenomenon of shift performance. This project was designed

to investigate empirically some of the factors which might affect a subject's performance of such discrimination learning problems, factors which have seldom been explored by the theorist, whatever his persuasion.

The observed differences in shifting ability are of this nature: rats and many other subhuman experimental subjects - Spence specified for his theory all "nonarticulate organisms" - find a nonreversal shift easier than a reversal shift. Kelleher (1956) and Davenport (1963) working with rats, Munn (1964) with kangaroos, Zable & Harlow (1946) through to Tighe (1964) with monkeys, Schusterman (1964) with chimpanzees, Alkow & Crawford (1966) with lizards, all these experimenters have reported the relative difficulty with which their laboratory animals make a reversal shift.

Bitterman's survey (1965) of the comparative literature in this area describes the progressive improvement in reversal ability from earthworm, cockroach, fish, decorticated rat, to turtle, pigeon, normal rat, and finally monkey. This apparent phylogenetic progression has been observed by several investigators. Years ago Zable & Harlow (1946) discussed reversing ability as a possible indication of level of intellectual functioning. Recently Rajalakshmi & Jeeves (1965) proposed an index of reversing facility as a method of assessing intelligence. They suggest

that the division of the number of trials or errors to criterion on a reversal shift by the number of trials or errors to criterion on the initial training task provides a technique for making both phylogenetic and ontogenetic comparisons. They have collected evidence from several species and with subjects at various chronological ages. Rumbaugh & Pournelle (1966) have independently made a similar claim that a reversal/acquisition ratio is a valid indicator of phyletic differences in intellectual capacity. Both pairs of investigators pointed out the superiority of the reversal index over other measures such as simple discrimination learning scores in terms of their reliability and validity as well as comparability. Warren, at a Symposium on Discrimination Learning (1967) at the University of Sussex, disputed the usefulness of such indices. He has not, at any rate, been successful in applying it meaningfully to some of the reversal data he has obtained in cats and kittens.

The importance of the effects of overlearning on reversal learning has been examined in a great many experiments. Just a few of these include the rat studies of Reed (1953), Bruner, Mandler, O'Dowd & Wallach (1958), Brookshire, Warren & Ball (1961 - both rats and chickens were used here), and Mackintosh (1962). These experimenters

have generally emphasized the facilitating effect of overlearning specifically on reversals. But this has not been universally substantiated. Hill, Spear & Clayton (1962) and D'Amato & Schiff (1965) found that both extradimensional and intradimensional shifts were improved by overlearning.

Despite such peripheral disagreements, the nonreversal shift has generally been found more easily performed by subhuman organisms than the reversal shift. There is also some consensus that there might exist a phylogenetic hierarchy in reversal shift facility in which the more complex the organism, the more easily it performs a reversal shift.

Adult human subjects, it is interesting to find, tend to perform a reversal more readily than a nonreversal shift. Berg (1948), followed by Buss (1952, 1953 and 1956) conducted much of the early work on human adult shift behaviour. Shifting was first investigated with humans as a method of testing rigidity and flexibility in a subject's thought processes. Kendler and his colleagues (Kendler & D'Amato, 1955; Kendler & Mayzner, 1956; and Kendler, Glucksberg & Keston, 1961) as well as Harrow and his (Harrow & Friedman, 1958; and Harrow & Buchwald, 1962) have extended the research, partly replicating the earlier studies

and partly refining the techniques for controlling various aspects of the experimental situation, such as the problem of partial reinforcement which confounded the results of the earlier experiments.

Extensions of the work with adults (subjects have usually been college students) have included both variations in experimental tasks and attempts to isolate some of the factors affecting shifting ability. These studies often record the facilitating effects of verbalization on transfers in discrimination. The reversal phenomenon in humans has been examined in the light of such factors as the effects of pretraining. Gagné & Baker (1950), Goss (1953) and McAllister (1953) studied this variable. Reports of similar investigations continue to appear. A recent example is the study of O'Connell (1965) who tested the effects both of instructions to verbalize and of partial reinforcement on reversal and nonreversal shifts. Although the impact of verbal pretraining, instructions to verbalize, and the like are always acknowledged, there is some conflict as to the exact direction of the effects. Overlearning, first observed with laboratory animals, has been investigated as a factor in adult shift performance by such experimenters as ~~Coleman~~ Paul (1966) and Uhl (1966). They found that both types of shift were aided if a subject overlearned the initial discrimination.

An important criticism of the Kendler research with adults has been presented by Isaacs & Duncan (1962). They believe that the Kendlers did not use adequate control groups in their experiments and that had they done so, they could simply have explained their results in terms of nonspecific transfer and a tendency to continue to respond to the dimension of stimuli reinforced in the training task. They used four experimental groups. Their control group and their group which performed a nonreversal to the original dimension learned best. These subjects were followed in proficiency by those who were obliged to perform a reversal shift. The worst performance was that of subjects required to shift nonreversally to a different dimension.

There are differences in the theoretical analysis of the results of these experiments, but, on the whole, the empirical evidence establishes the ease with which most adult humans perform a reversal shift in discrimination as opposed to a nonreversal shift, in contrast to the relative ease with which animals carry out a nonreversal shift in comparison with the reversal shift. Also, the evidence on verbalization suggests it may be a critical factor in the successful performance of discrimination shifts, in general, and particularly of intradimensional or reversal shifts.

One hypothesis which has been proposed to explain the reversal phenomenon is that of mediation. This explanation

has been invaluable to behaviourists in the Hullian tradition, since without such a construct there seemed to be no way of explaining the reversal phenomenon and related issues in human task performance. For instance, Kendler & D'Amato (1955), examining the card sorting behaviour of groups of college students found that a single unit S-R hypothesis would predict that a nonreversal shift would be executed more readily than a reversal shift. The build up of response tendencies in the initial card sorting would lead to a superior extradimensional shift. Since this in fact did not occur, they hypothesized mediating stimuli and responses to occur between the observed stimuli and the observed responses. Kendler & D'Amato said that their analysis of discrimination learning,

> "...assumed that such behaviour on any one trial consisted of a sequence of two S-R associations. According to this formulation, the stimulus component of the first association would represent the test cards while the response would refer to the symbolic response made to them and the stimulus of the second association would represent the cue produced by the preceding symbolic response, while the response would be the overt card-sorting behaviour. The specific hypothesis tested was that the presence of the appropriate symbolic cues, even though they might be connected to the wrong sorting response, would facilitate concept formation.
>
> According to this hypothesis, a reversal shift would occur at a more rapid rate than a nonreversal shift because at the completion of the learning of the first concept, the symbolic cues appropriate to the second concept would be present for the Ss in the reversal group; they would merely be connected to the wrong sorting response" (Kendler & D'Amato,1955,pp.173-174).

This explanation in terms of mediating stimuli and responses is simply an extension or modification of Spence's original formulation concerning discrimination learning in animals. Since so much of the U.S. research clearly originates from Spence's single unit S-R analysis of animal learning it seems important to review it at least in outline.

Spence's analysis of discrimination learning in subhuman organisms was outlined in articles published by him in 1936, 1937 (a & b), 1941, 1942 and 1945. Briefly, he stated that,

> "...discrimination learning is conceived as a cumulative process of building up the strength of the excitatory tendency of the positive stimulus cue (i.e. the tendency of this stimulus to evoke the response of approaching it by means of the successive reinforcement of the response to it, as compared with the excitatory strength of the negative stimulus, responses to which receive no reinforcement.) Theoretically, this process continues until the difference between the excitatory strengths of the two cue stimuli is sufficently large to offset always any differences in strength that may exist between other aspects of the stimulus situation which happen to be allied to their action with one or another of the cue stimuli. That is to say, the difference between the excitatory strengths of the cue stimuli, positive and negative, must reach a certain minimum or threshold amount before the animal will respond consistently to the positive stimulus" (Spence, 1937b, pp.431-432).

Many experimenters using animals as subjects report confirmation of Spence's analysis. Against his critics, who ignored the fact that Spence carefully specified the

boundary conditions for the appropriate application of his theory, he said,

> "...I have long since lost track of how many 'disproofs' there have been of my theory of discrimination learning in nonarticulate organisms (Spence, 1936,1937) that have employed college sophomores as subjects. It is possible, of course, that the difficulty in this instance is merely a semantic one in that these investigators have regarded the term nonarticulate as applicable to college sophomores" (Spence,1956,p.202).

In any case, acquisition of a correct response is seen by Spence in terms of the cumulative change brought about by competing sets of excitatory tendencies. His emphasis on the importance of reinforcement and frustration or inhibition produces a picture of the laboratory animal acting in terms simply of increments and decrements of response strengths. The rat, or chimpanzee, if presented with our problem of discrimination in which size and brightness are the important dimensions, would build up not only a positive response tendency to the rewarded stimulus, but also negative tendencies to the aspects of the stimuli which are never reinforced. Spence said:

> "Thus it was found that the learning of form discrimination problems by our chimpanzee subjects was directly dependent on the relative excitatory strengths of the positive and negative stimuli as determined by the relative number of reinforcements and frustrations (non-reinforcements) they had received in previous problems" (Spence, 1937a, p.98).

If the animal is rewarded for responding to <u>black</u>, his

tendency to respond to white is inhibited, and his response tendencies to the size dimension, if reinforced at random, will be distributed approximately evenly between the two aspects of this dimension. In the event that a reversal shift is required, not only must the tendency toward the initial stimulus (black) be inhibited, but so must the inhibitory tendency away from white be altered, whereas, to learn to respond to the new dimension (size) is relatively easy. The animal, it will be recalled, has been partially rewarded already for responses to each aspect of the size dimension, so the breakdown and reconstruction in response strengths in this case are much less complex. As Spence said (1937b, p.430), in this particular type of experiment "...the relevant stimulus component is always reinforced and never frustrated, whereas, irrelevant components receive both reinforcement and frustration."

As we have seen, however, this model is not helpful for the analysis of adult human shifting behaviour. Moreover the "relative theorists" such as Lashley and his followers find the model unsuitable for the analysis of the behaviour of any organism. They maintain, and perhaps correctly, that the organisms' perception of relations, their responses to ratios of excitation can more profitably be viewed in themselves as explanatory principles. The role of perceptual organization is seen by many theorists who oppose

the simplistic S-R behaviourists to be as critical to the analysis of such behaviour as that involved in learning and transposition in any experimental situation. Hunter (1953), for instance, reported that transposition behaviour in children can better be seen in terms of Lashley's relative theory than Spence's absolute one. I shall discuss in more detail a little further on the work of N.S.Sutherland, an advocate of Lashley's type of approach. In the meantime, reference should be made to the work of Broadhurst and Eysenck in relation to this type of theoretical dilemma. As Eysenck says (1966) it is very important in such controversies that we examine the personality, emotional, and motivational characteristics of the experimental milieus involved (perhaps both of the experimenter and of the rat!). It is rather encouraging to think that perhaps when more aspects of the experiment are controlled, such as the strain of experimental animal observed, the stimulus, and so on, some of these contradictions will resolve themselves.

In any case, the value of the mediational hypothesis can clearly be seen in the context of its behavioural precursor. It has been used as a means of explication for a great number of situations in which a single-unit behaviourist analysis is unsatisfactory. What is the nature

of mediators? When are they used as explanatory principles? What kinds of behaviour do they signify or predict? Kendler, Kendler & Learnard explain,

> "For those who investigate higher mental processes within the domain of S-R psychology the concept of the mediating response is of singular importance. It is usually treated as a response which intercedes between the external stimulus and the overt response to provide stimulation that influences the course of overt behaviour. Since this response is, ordinarily, more often implicit than explicit, its investigation poses problems. One method of dealing with such problems...is to infer the process from overt behaviour as manifested under a prescribed set of conditions. In this...method the mediated response has the status of an hypothetical construct which may or may not be ultimately measurable, but which justifies its use by its theoretical and heuristic function" (Kendler, Kendler & Learnard,1962,p.571).

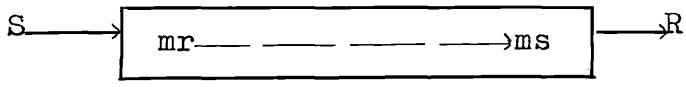
Although the Kendlers stress the mediating response, both mediating stimuli and mediating responses are posited. These hypothetical constructs have been analyzed in particularly close detail by Goss (1961 and 1964).

Goss says that they are used as <u>postfactum</u> explanations for such behavioural phenomena as: latencies of response longer than those thought to be necessary for a subject to make a response, reduced but observable activity of usual terminating responses, and posture change or receptor-orienting responses. They are also used to rationalize subjects' retrospective reports of plans or

strategies; changes in the relationship between stimulus and response caused by instructional, motivational, situational, or experimenter variables; predictions from principles of previous experiment observation, like those of verbal mediating responses from verbal responses under comparable circumstances. Finally, mediators are used as hypotheses in the case of an explanatory dilemma. Goss attempted in his analysis of the use of mediation to show that such concepts as abstract set or attitude, hypotheses, and strategies can largely be subsumed under the mediational construct. Mediating responses and stimuli appear to him to form relationships between each other which actually constitute a type of set. He explains the congruency between these concepts in terms of findings on shifting behaviour, sequences of receptor-orienting responses and the persistence of covert or overt verbalization and rehearsal.

The behaviourist can now see his subject as being capable of generalizing from previous experience, and as having at his command both a broader range of cognitive choices, and a greater cognitive flexibility than previous behavioural theoretical formulations could accommodate. Thus a subject, in approaching the discrimination learning problem described in some detail earlier, can be considered to be

learning to recognize and discriminate on the brightness or colour dimension when he responds to black on the initial discrimination. Perhaps he says to himself "I'm supposed to choose black" or "It's the colour that's important", or "It's never white." Or perhaps he selects for his attention only aspects of the stimuli which he notices most clearly as he is rewarded for a correct response. In any case, the mediation which has taken place would still be of some relevance when the subject is required to shift his response to another aspect of the same dimension. In this example, white would be the correct reversal response. The same stimulus mediators are relevant. Only the response must be altered. The familiar representation (Figure B) of the stages of mediation in its most simple form is a useful reminder.



stimulus ⟶ mediating responses and stimuli ⟶ overt response

Figure B. Representation of mediation

The subject in this formulation is described as responding to a stimulus not in the single unit S R fashion. Rather, he can respond implicitly (mr), produce his own cues (ms) which then provide scope for his overt

response, suitably mediated in terms of his past experience, cognitive structure, perceptual set, and the like. Kendler says,

> "The mediated response is one of the mechanisms most often used to find a common theme between simple and complex behaviour within this (S-R learning) theoretical framework. The mediator is a response or a series of responses, which intercede between the external stimulus and the overt response to provide stimulation that influences the eventual course of behaviour. These responses may be overt, but they are usually presumed to be covert. The mediated response is not an original idea. All theories of thinking, motor or central, behaviourist or phenomenological, dealing in the second-signal system or using computer models, postulate internal processes that intervene between the presentation of the problem and its solution, between input and output, or between the stimulus and the response. The differences arise in the model used to generate hypotheses about the nature of this internal process, and in the methods used to validate these hypotheses. Watson, who coordinated thinking with subvocal talking, used conditioning as his model and sought verification by direct measurement of the muscles of speech. The contemporary behaviourist approach allows for a wider range of mediating responses and for the possibility of treating them as theoretical constructs rather than as directly observable behaviour" (Kendler, 1963,p.34).

Mediation seems discouragingly similar to the black box which locates a soluble problem in engineering design, indicates that an operation is performed, but does so without in any way explaining how it is performed. By putting a square around additional S-R connections, we are simply identifying or signifying the existence of the problem. Until much more is known about the mechanisms operating

between both the organism and the stimulus, and the organism and the response, the complex behaviour of an experimental subject cannot be explained or predicted. A black box cannot greatly illuminate our discussion.

In search of clues to questions about the nature and development of mediating processes investigators began to examine the performance of children on discrimination learning and shift tasks. They were inspired by such early studies as that of Pyles (1932) which indicated the facilitating effects of verbalization in children's learning, and encouraged by the results of Margaret Kuenne Harlow (Kuenne, 1946) and Alberts & Ehrenfreund (1951) who demonstrated a qualitative difference in transposition behaviour between rats and children.

The latter two studies were designed as tests of the applicability of Spence's theory to the behaviour of young children. The results seemed to support the hypothesis that infrahuman organisms respond similarly to children in a preverbal stage of development. But once the acquisition of verbal processes reaches a certain stage in development (Kuenne, 1946,p.488), "...and (with) the transition to behaviour dominated by such processes...the child's responses in the discrimination learning situation become keyed to words related to the cue aspect of the stimuli." It was suspected that the transition to verbal control is not a

simple process. There were speculations about a developmental process remarkably similar to that suggested by Luria:

> "While the data on verbalization are not sufficiently clear-cut to permit any definite conclusions, there is, however, the suggestion that there are at least two developmental stages so far as the relation of verbal responses to overt choice behaviour is concerned. In the first the child is able to make differential verbal responses to appropriate aspects of the situation, but this verbalization does not control or influence his overt choice behaviour. Later, such verbalizations gain control and dominate choice behaviour" (Kuenne, 1946,p.488).

Do young children, then, perform more like laboratory animals or like human adult subjects when a discrimination learning situation involves reversal and nonreversal shifts? The Kendlers first examined this issue (Kendler & Kendler, 1959) by testing the shifting performance of a group of five to six year old children. Their results proved most provocative. The children performed both types of shift with equal ease. Suspecting that they had happened upon a group of children in a critically important transitional phase in their development, they tested (Kendler, Kendler & Wells, 1960) a group of children a little younger than the previous group. The younger subjects, with a mean age of four years, performed the nonreversal shift more readily than the reversal shift. Instructions to verbalize had no

significant effect on their performance. This finding was interpreted as indicating that the children were perhaps at a stage in their development in which their activities were not yet mediated by words. The Kendlers refer both to Luria and to Kuenne on this point (Kendler & Kendler, 1962). The next step for them was to take a relatively broad age range of children (ages three to ten years) and to observe the relative facility with which each type of shift was performed. Increasingly larger proportions of children performed the reversal shift better than the nonreversal shift (Kendler, Kendler & Learnard, 1962). This particular experiment was designed so that a shift preference could be observed. The finding that 37.5% of three year olds, 50% of children between four and six and ultimately 62.5% at age ten exhibited a tendency toward reversal rather than nonreversal responses complemented Buss's finding (1956) that 72% of college students choose a reversal shift.

One further comparative study should be mentioned. Kendler, Kendler & Silfen (1964) studied the shifting preferences of albino rats and thus contrasted their performance with that of the children. Again, freedom was given so that subjects could shift in a reversal, nonreversal or inconsistent way. Figure I in Appendix B (which starts on page 232) shows the comparisons that were made. Their rats did perform in a manner which might be

interpreted as a downward extension of the Kendlers' developmental hypothesis.

The Kendlers found in all their studies that children who learned the initial task most quickly were the ones who reversed best. Although IQ test items were given to the children in the 1962 study (Kendler, Kendler & Learnard) so that the experimental groups could be compared, no check was made of the relationship between IQ score and reversal performance. (It should be noted that the means of the IQ scores for each experimental group ranged from 112 to 120: a bright sample!) Rajalakshmi & Jeeves(1965) have, however, reported a high degree of relationship between reversal learning and intelligence as measured by certain WISC items and by Goodenough's Draw-A-Man Test. Their subjects were six to eight years old. Osler and her associates have carried out a series of experiments relating IQ score to the ability to mediate successfully in concept learning situations (Osler & Fivel, 1961, Osler & Trautman, 1961 and Osler & Weiss, 1962). They pointed out the relevance to the Kendlers' studies of the finding that superior concept attainment on their tasks was achieved by high IQ scorers. They attributed rapid concept formation in their subjects to the possession of mediators such as those postulated by the Kendlers. They stated that these mediators are available at an earlier age to brighter children.

Interest in mediation has mounted over the last fifteen years. Jeffrey's 1953 study was comparatively isolated but now programmes of research constitute interrelated networks like that of Osler and her associates, the Kendlers, and those of Reese. Reese reports significant age trends in the development of mediators (Reese, 1962a), the facilitating effects of overlearning with seven year olds (Reese & Fiero, 1964), and the importance of perceptual set mediation with prescholars (Reese, 1965). He has written a helpful summary article on mediation (1962b). Some experimenters emphasize the relationship between verbalization and the hypothesized mediators. Others prefer to stress the perceptual origins of mediators (e.g., Tighe, 1965).

Of their concern with verbalization, Kendler, Kendler & Learnard said,

> "...although these results cannot point to a perfect relationship between verbalization and choice behaviour, the similarity of trends certainly suggests that the development of the mediational processes is intimately related to the development of the ability to relate words to action" (Kendler, Kendler & Learnard, 1962, p.583).

The theoretical articles (Goss, 1961 and Kendler, 1961) are buttressed by considerable experimentation. We have already discussed some of these experiments. Other important ones include: Carey & Goss (1957), Goss & Moylan (1958), Kendler & Karasik (1958) and Kendler (1964). In this latter study

Kendler designed two experiments which allowed her to investigate the function of verbalization on reversal learning. She reported that the children could be categorized developmentally in a manner similar to that suggested by Luria: first are the youngest subjects who do not reverse even when given verbal labels indicating the correct reversal response, second are the children who reverse only when the reversal response is verbalized for them, and third, those who generate their own verbal representations and thus readily perform a reversal shift. Weir & Stevenson (1959) have noted the interacting and differential effects of age upon verbalization.

Marsh, examining the effects of overlearning on very young children found (like Kendler, Kendler & Wells, 1960) that 36 to 48 month old human subjects learned a nonreversal shift faster than a reversal shift, and that overlearning facilitated discrimination reversal but not nonreversal shifts. This finding which replicated that with nonverbal organisms is explained by Marsh in terms of response to a dimension of a perceptual type. He said (1964, p. 1371), "It is possible that a perceptual response to a dimension develops prior to verbal mediation and that the latter is dependent on the former." Youniss & Furth (1965) have also reported the positive effects of overtraining with young children, and Tighe (1965), the effects of perceptual

pretraining on shift performance. McConnell, following Piaget & Werner, suggested that in young children where there is a deficiency in verbal mediation, perhaps perceptual mediation is used to solve discrimination problems. He demonstrated that younger children could be aided by perceptual pretraining. This seems to indicate that perceptual "mediational effects could be achieved in younger children which are similar to those obtained by verbal means in older children" (1964, p.1381). He concluded,

> "Furthermore, the finding of the present study suggests that it is an oversimplification of the problem to ask simply at what point on the evolutionary continuum a transition is made from single-unit to a mediated mode of responding. Further attempts need to be made to differentiate the various types of mediating processes which may be used and their relevance for different conceptual tasks at various stages of development" (McConnell, 1964, p. 1381).

Milgram & Furth (1964) and Sanders, Ross & Heal (1965) have compared reversal shift performance between normal and subnormal subjects. Milgram & Furth reported significant age and IQ differences on reversal; Sanders, Ross & Heal found reversals were easier for normal subjects than nonreversals, but that there were no significant reversal-nonreversal differences for retardates.

Perhaps studies of the effects of instruction on the behaviour of subnormal as compared with normal children can

also enlarge our understanding. Bryant[1] (1964) has found, for instance, that whereas instructions on an original task facilitate transfer performance in normals, the transfer of severely subnormal subjects is impeded by initial instructions. Moderately retarded subjects (Bryant, 1965a) were not affected in transfer by previous instructions. Bryant has pursued the study of verbalization by examining the effects of verbal labelling on recognition and recall (1965b& 1965c) in normal and severely subnormal children. Although outside the mainstream of verbalization studies, projects of this kind add to our body of knowledge concerning the function of language in concept formation and discrimination learning.

Vast numbers of studies with children have investigated the function of verbal mediation in terms of both "acquired equivalence of cues," (AEC), or mediated generalization and "acquired distinctiveness of cues," (ADC), or stimulus discrimination. These concepts are highly related and stem from Hullian associationistic principles. Jeffrey (1953) referred to Hull's Principles of Behavior in which he said:

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1. I am most grateful to Dr. Bryant for having sent me a great deal of information concerning his recent experiments.

> "...the common-sense notion of similarity and difference is based upon the presence or absence of primary generalization gradients, whereas so called logical or abstract similarities and differences arise from secondary learned, or mediated similarities and differences particularly those mediated by verbal reactions" (Hull, 1943, p. 194).

Many of the more important investigations of AEC and ADC can be found in Palermo & Lipsitt's excellent anthology (1963). In 1956, Spiker surveyed the critical factors and early evidence concerning these concepts; he wrote another survey in 1963. That these studies are highly interrelated can be seen in the following brief review. Cantor (1955) studied three to five year olds and found that the possession of names for stimuli facilitated discrimination learning. Schaeffer & Gerjuoy (1955) also reported that stimulus names facilitated learning in kindergarten-aged subjects. Dietze's 1955 study involved the effects of verbalization on both stimulus generalization and discrimination in four and five year olds. Norcross & Spiker (1957) confirmed Cantor's 1955 study, and in 1958 they expanded the previous work with kindergarten and first grade children. Gerjuoy (1964) studied third and fourth grade children. Shepard & Shaeffer (1956) studied mediated generalization in sixth grade children. Generally, verbal labelling aids the learning performance of children both in discrimination and in generalization.

An altogether different approach to discrimination learning has been proposed recently by Sutherland. His theory has been advanced in the belief that only by carefully examining the relationship between the stimulus and the organism can we understand many of the behavioural phenomena in discrimination situations which at present trouble psychologists. He has said of the S-R approach,

> "The phenomena of animal learning have been studied mainly by American behaviorists such as C.L.Hull, and they concentrated on the problem of how new responses are learned. However, it will be argued here that perceptual processes play a vital part in learning and that the phenomena of learning cannot be fully understood without taking perceptual processes into account" (Sutherland,1964a, p. 149).

Sutherland's analysis derives from the work of Lashley and Krechevsky in the 1930's and from the more recent work of Lawrence. His earliest detailed presentation of the theory, "Stimulus Analysing Mechanisms" was published in 1959. At that time most of his exploratory research had been conducted with octopuses (these projects include studies of octopus discrimination of squares and triangles, 1958, open and closed forms, 1960a, squares and rectangles, 1960b, horizontal and vertical extents, 1961a and a summary, 1964b).

Sutherland has suggested (1958) that there are specific analyzing systems available to the organism. In discrimination learning, the subject must learn both to switch on the correct analyzing mechanism and to attach a

correct response to the output of that analyzer. He said:

> "To summarize this crudely, in the model envisaged the brain is being viewed as containing at least three different boxes: 1) A number of different analysing mechanisms. 2) A control centre which determines which of these mechanisms shall be switched in on any given occasion and in what sequence they shall be switched in. 3) A further box which is responsible for selecting the response to be attached to the output from the analysing mechanisms. This is obviously a gross oversimplification and in practice the boxes may turn out to be not so very discrete, but it is worth seeing how far available evidence supports this conception" (Sutherland, 1958, p. 589).

The stages involved between the stimulus input and the responses include analyzers and their outputs as well as attachments. The hypothesized stages in Sutherland's model were drawn in a diagram in his summary article in 1964 (1964a, p. 149). This figure is reproduced in Figure 2 in Appendix B of this thesis. It should be read from the bottom upwards.

This model has two important characteristics. First, the nervous system is seen as being capable of only handling one stimulus input at a time. There is ample evidence that organisms can only process serially sensory stimulation. The other feature of the system is its ability to operate on the basis of relative quantities rather than on absolute terms. Although tending to the relativist position, Sutherland did point out (1959, p.591) that the theoretical disagreements between Spence and Lashley have yet to be

resolved satisfactorily owing to methodological flaws in the experiments designed to establish either position. It is interesting to note also that Sutherland has been using in his rat experiments (1961b, 1964a) the Lashley jumping stand. Eysenck's interest in the psychology of the experimental situation (1966) comes once again to mind. Does Spence's equipment tend to force the rat's behaviour toward reinforcement-bound responses and does Lashley's encourage responses which to a greater extent depend on relative judgments concerning stimulus input?

Sutherland's theory does seem admirably suited to fill several gaps in a theoretical discussion of discrimination. Application of the model described in Figure 2 (in Appendix B) helps to explain the phenomena of overtraining as it facilitates reversal learning, the organism's reported ease of transfer along a continuum, and the effect of partial reinforcement on resistance to extinction. Sutherland has demonstrated (1964a) how his model explains each of these experimental findings. It is plain from his exploratory studies to date, that the examination of the processes whereby stimuli are analyzed is necessary for a complete understanding of discrimination. Several recent experiments examining the usefulness of Sutherland's model have involved negative findings. Matthews (1966) has argued that the

functional stimulus may not be the nominal one, for instance. At a Symposium on Discrimination Learning, held in Brighton (April 1967) a number of papers reported contrary experimental results, the most notable being Sigel's paper in which he stated that Sutherland's stimulus analyzers did little to explain the behaviour of his laboratory animals. A great deal more research must be done examining the Sutherland model, and certain modifications should be made. Sutherland at Brighton mentioned the need for instance to incorporate the notion of hierarchies of analyzers. Visual analyzers in humans are quite obviously more important than olfactory ones.

This concludes the historical consideration of the development of the tasks involving reversal and nonreversal shifts as used in the present study. The fact that they have been developed for use with many types of subject makes them of considerable interest. The questions engendered concerning simplistic behaviour theory and the variety of hypotheses that they continue to elicit make them seem to be of considerable value both theoretically and experimentally. It is informative to examine results in the context of a very extensive and interesting body of research evidence and theoretical controversy. Because the tasks developed originally from the rat laboratory, it seems

to have taken researchers a very long time to relate them to a great variety of factors which researchers in other fields of psychological investigation agree to be of critical importance to intellectual performance. We know that the development with age of the preference for reversal over nonreversal shifts has been documented by the Kendlers. They have also reported the relationship between speed of learning on the initial task and reversal performance. They and others have indicated the effects of verbalization. Scored IQ has been shown to be related to reversal facility. There have, however, been no attempts to examine the effects of previous experience, motivational or even sex differences, or, indeed general verbal facility on the successful performance of this task. A search of the literature in the social and developmental spheres of psychological interest provided some interesting hypotheses which promised to enrich and perhaps clarify some aspects of a problem originating in the behavioural mould.

It was decided that it would be fruitful to investigate some of the factors which might be affecting the reversal behaviour of children at the developmental stage isolated by the Kendlers: the period in which half of the children seem to be performing a reversal shift most readily, and the other half, the nonreversal shift. This transitional

behaviour appears to be most marked between the ages of five and seven. It is important to know what other orientations can tell us about the problem solving or concept formation behaviour of children at about this age. Quite obviously there are many investigators more deeply concerned than are the behaviourists with the developmental roots of thought processes. And it is to some of these investigators to whom we shall turn now.

Shift learning in the context of developmental studies

From basic assumptions quite different from those of the behaviourists and with reference to entirely different experimental rationales, very similar problems of concept attainment have been investigated. Emphases obviously differ as well, but it is most interesting to find that results are often very similar. What do developmental psychologists say, for instance, about the ability of a child to reverse an already learned concept? What is the evidence concerning the importance of perceptual and verbal skills in the early stages of youthful concept formation?

Piaget is obviously an important figure in this area. Since any sampling of Piaget's was necessarily scattered and incomplete, Flavell's Developmental Psychology of Jean Piaget (1963) was valuable both as a guide to the original sources and for clarification. Five books of Piaget's seem to bear directly on the present discussion: Judgment and

Reasoning in the Child, The Psychology of Intelligence, Logic and Psychology, The Language and Thought of the Child and The Origin of Intelligence in the Child. Piaget's conception of the child's cognitive development places considerable stress on behaviour very similar to that exhibited in the reversal task situation. His emphasis on an increasing flexibility in thought processes with age makes an examination of his view of the development of the young child seem promising. A brief summary of the main characteristics of each developmental phase is given in Logic and Psychology (1957, pp.8-22); they will not all be discussed in detail here.

Piaget outlines four major phases in the development of cognitive processes from infancy to adulthood. The sensory-motor period involves the development of the child from birth to the age of approximately two years. From the ages of two to seven the child exhibits increasingly differentiated and sophisticated forms of pre-operational thought. It is the latter stages of this phase which concern us most. At the beginning of this period language emerges and it becomes possible for actions to be internalized into thoughts. Piaget divides the preoperational period into a) the beginnings of representational thought (between 2 and 4 years), b) the emergence of simple representations or intuitions (between 4 and 5½ years), and c) the articulation

of intuitions or representations (at 5½ to 7 years). The period of concrete operations occurs between the ages of seven and eleven. The final period of development, with propositional or formal operations begins at age eleven and stabilizes by fourteen or fifteen years of age.

Although Piaget has emphasized in all of his treatments of preoperational thought the onset and development of symbolic function this is accompanied by the conspicuous absence of the ability to reverse cognitive operations. Flavell has emphasized Piaget's insistence on this:

> "Perhaps the most important single characteristic of preoperational thought for Piaget is its irreversibility. (He proceeds to amplify the concept of reversibility). In a general way, a thought form which is reversible is one which is flexible and mobile, in stable equilibrium, able to correct for distorting superficialities by means of successive, quick-moving decenterings. But the turgid, slow-paced, and extremely concrete mental experiment of preoperational thought is not reversible, parroting as it does irreversible events in reality" (Flavell, 1963, p.159).

The growth toward the kind of flexibility involved in reversibility which begins to emerge in the last part of the preoperational period should be seen in the context of other aspects of this period. The preoperational child is egocentric in the sense that he takes his own current frame of reference as fundamental; everything is interpreted in relation to "me". Egocentricity in this specialized sense does not preclude curiosity about, or play with other

children, but it does include difficulty on the part of the child in seeing how even simple spatial relations may appear to another, or how two objects spatially related might appear to each other. The child's thought at this stage is static, unstable, concrete, animistic, and so forth, but above all else, it is irreversible. At about age seven, however, the child is beginning to show signs of articulated operations:

> "The rigid, static and irreversible structures typical of preoperational thought organization begin, in Piaget's phrasing, to 'thaw out' and become more flexible, mobile and above all decentred and reversible in their operation" (Flavell, 1963, p.163).

This flexibility is accompanied by an increasing stability and equilibrium in the child's thought processes. For Piaget (1928, p.177) this equilibrium involves an increasing coordination and complementarity in the processes of assimilation and accommodation.

Intellectual adaptation involves the balancing of the two invariant processes: assimilation and accommodation. Using an organismic model, Piaget has described the process of assimilation as a moulding or interpretation of external reality in terms of the individual's existing cognitive organization or structure. Accommodation, also seen in organismic terms, involves the adjustment or active adaptation of the individual in order to accommodate himself to the

external world. These are reciprocal processes which work together, modify, manipulate, and balance the development of mental structures or schemes. Piaget quite clearly identified the increase in reversing ability with the onset of intellectual balance when he said:

> "This equilibrium can be quite shortly defined as the reversibility of the operations in the balance. A noncontradictory operation is a reversible operation. This term must not be taken in the logical sense which is derivative, but in the strictly psychological sense. A mental operation is reversible when, starting from its result, one can find a symmetrically corresponding operation which will lead back to the data of the first operation without these having been altered in the process" (Piaget, 1928, p.171).

This process emerges first in the form of empirical reversals which eventually amalgamate and mobilize as a functional intellectual skill. (Piaget, 1950, p.141) "... the younger children have already on occasion admitted the possibility of a return to the starting point, without this 'empirical reversal' yet constituting a complete reversibility." As operations become more reversible, the child's thought becomes less egocentric. Piaget said of this process,

> "...as soon as thought becomes socialized, a momentous factor comes into play; imitation and assimilation are transformed, solidarity is established between them and thought becomes increasingly capable of reversibility. the child will henceforth attempt to weave a network of reciprocal relations between his own point of view and that of others... Social life, by developing the reciprocity of relations side by side with the consciousness of necessary implications will therefore

> remove the antagonistic characters of assimilation and imitation and render the two processes mutually dependent. Social life therefore helps to make our mental processes reversible and in this way prepares the path for logical reasoning" (Piaget, 1928,p.180).

From the age of seven onward, then, concrete operational thought predominates. It is interesting to note the emphasis Piaget has placed on the importance of the child's experience to his cognitive development. We will return to that a little later.

The overlap in the terms reversal facility as used by the behaviourists and reversibility as used by Piaget deserves consideration. It would seem that increasing ability to perform reversals in a concept learning situation would be an example of development of the very broadly conceived intellective process termed reversibility. Piaget's term encompasses a great deal; as we have already seen, he uses it almost interchangeably with equilibrium. Reversal shifts would be a single instance of the type of behaviour which Piaget would term reversible in nature. A reversal shift might best be described in Piagetian terms as one example of an empirical reversal. That clarified, the empirical work of the behaviourists seems to support Piaget's analysis. One very interesting recent work on concept formation in older children seems to demonstrate still further corroborative evidence. Osler & Shapiro (1964) reported results of a behavioural study which seem to suggest

confirmation of the transition from concrete operations to formal operations at about age ten.

Flavell's portrait of the developmental stages Piaget has described is appropriate at this point. This impressionistic sketch of the child as he develops is rather attractive in that it does seem to capture much of the essence of the child as Piaget has revealed him to us:

> "What could be the archetypes for the three post-infantile eras. The preoperational child is the child of wonder; his cognition appears to us naive, impression-bound, and poorly organized. There is an essential lawlessness about his world, without, of course, this fact in any way entering his awareness to inhibit the zest and flights of fancy with which he approaches new situations. Anything is possible because nothing is subject to lawful constraints. The child of concrete operations can be caricatured as a sober and bookkeeperish organizer of the real and a distruster of the subtle, the elusive and the hypothetical. The adolescent has something of both... Unlike the concrete operational child he can soar; but also unlike the preoperational child it is a controlled and planned soaring, solidly grounded in a bedrock of careful analysis and painstaking accommodation to detail" (Flavell, 1963, p.211).

It is unfortunate that Piaget does not appear to have devoted a great deal of his time in his experimental work specifically to exploring the nature of that quality of human thought which he termed reversibility. We are usually referred to his conservation studies for examples of reversibility, but since it is such an inclusive principle, it would seem important to examine its development in several

of its many aspects. And this does not seem to be the sort of thing that his followers have been inclined yet to do. Although the criticism is made that Piaget has based his theory on too scanty an empirical base and although many replication studies find inconsistencies in such matters as the chronological age at which certain of the developmental phases can be expected to begin, vast numbers of studies provide quite interesting, and sometimes, I should think, unexpected substantiation. A recent study by Goodnow (1962), for instance, reported the examination of several cultural groups in Hong Kong. She concluded that although some of her results indicated a need for clarification of the concepts involved, the similarities across cultural milieus were more striking than the differences. Obviously Piaget can and has been criticized and even disregarded because of the clinical method which he has employed. The richness and scope of his insights have however been a function of the method and can thus be seen as its quite ample reward.

Translated literature from the Soviet Union, such as that of Luria and his colleagues, provides us with further satisfying and quite independent substantiation of the American behavioural research on mediation. Luria says, for instance (1957, p.124), "When a child develops normally,

the closest interaction between the two signal systems is established as early as the age of five or six, and, under laboratory conditions, the abstracting and generalizing function of language begins to play a decisive role in the development of new connections." The Pavlovian first signal system has proved as inadequate to account for even rather simple human conceptual behaviour as the single unit S-R associationism. A second signalling system was consequently postulated. Pavlov regarded words as signals or symbols of the immediate signals of reality which were obtained through analyzers, or the senses. Language, then, makes possible the second signalling system. The development and nature of this second signal system has been extensively explored in recent years.

Berlyne's summary article (1963) and Leont'ev's 1961 discussion of current problems in Soviet research provide an accessible overview. Many of the articles in the book which O'Connor edited (1961) touch on the development of the second signal system. But the most interesting recent publication is that of the translation of the long untapped studies of Vygotsky (1962 - in paperback, 1965). Recent studies apparently owe much to the work of Vygotsky which was conducted in the late 1920's and early 30's.

According to Bruner, in his introduction to Vygotsky's Thought and Language,

> "Vygotsky has indeed introduced an historical perspective into the understanding of how thought develops, and indeed what thought is. But what is interesting is that he has also proposed a mechanism whereby one becomes free of one's history. It is to Vygotsky that Soviet psychologists turn in examining the manner in which man fights free from the dominance of stimulus-response conditioning of the classical Pavlovian type. Vygotsky is the architect of the Second Signal System, proposed by Pavlov in reaction against the excessive rigidity of his earlier theories. It is the Second Signal System that provides the means whereby man creates a mediator between himself and the world of physical stimulation so that he can react in terms of his own symbolic conception of reality" (Bruner, in Vygotsky, 1965, pp. ix-x).

Vygotsky's provocative account of the developmental stages which he has observed in concept formation should be summarized briefly. In the first stage, the child groups objects in heaps which are quite unorganized: diffuse and syncretic. These syncretic heaps are created at first in a trial-and-error, random fashion. A little later they are constructed spatially, organized primarily in terms of the child's visual system. Finally elements from different heaps are combined to produce a more complex organization. There is now what Vygotsky terms an "incoherent coherence".

In the second major phase in the development of mature concepts, thinking functions in terms of complexes. The bonds of union in complexes exist between the individual objects in reality as well as psychologically. Complexes are at first primarily associative. Then they become

collections; here objects are combined when they differ on one particular aspect. The chain complex comes next. It is a consecutive joining of links in which the criterion of linkage can alter along the way. The next stage, the diffuse complex, is more flexible, indefinite and unstable. Finally, the pseudo-concept: this resembles an adult concept externally, but is really still a complex in that it is still guided by visual likeness and is limited to perceptual cues. It would seem that five to seven year old subjects perform in a discrimination learning and shift experiment in a manner very much like that described by Vygotsky's stage of complexes.

Ultimately, the advanced concept is possible. Balanced conceptual organization is constructed through the unification of scattered impressions, of abstraction, and of synthesis. How is the development of this flexible mode of thought fostered? Vygotsky says,

> "Verbal intercourse with adults...becomes a powerful factor in the development of the child's concepts. The transition from thinking in complexes to thinking in concepts passes unnoticed by the child because his pseudo-concepts already coincide in content with the adult's conceptions. Thus the child begins to operate with concepts, to practice conceptual thinking, before he is clearly aware of the nature of these operations. This peculiar genetic situation is not limited to the attainment of concepts; it is the rule rather than an exception in the intellectual development of the child" (Vygotsky, 1965, p. 69).

More recent investigations, although perhaps not so brilliantly conceived as Vygotsky's contributed much empirical

evidence concerning the chronological events involved in the development of complex thought processes. Berlyne (1963, pp.172-173), for instance, has described an untranslated study of Paramanova in which three year olds had much more difficulty learning and reversing than five to six year olds who reversed rapidly and without difficulty. The explanation given was that the older children were behaving in terms of the second signal system. According to Liublinskaya,

> "The development of the child's speech is possible only on the basis of the first signal system. It is only on the basis of simple conditioned connections and a fine analysis of speech sounds that the connections of the second signal system can be formed. Then the child can master words as signals, which generalize a whole group of similar stimuli by abstracting the essential common features" (Liublinskaya, 1957, p.198).

Although the role of language in the formation of complex intellectual behaviour is strongly emphasized, intellectual growth is seen as a complex process of development rooted in very early learning processes:

> "...in children:
> 1) The development of cognitive activity, beginning with perception and concluding with abstract thinking, requires familiarity with the mother tongue. The mastery of language appears as a condition of generalized human reflection of objects, their features, activities, and so on.
> 2) The development of sense perception is inseparably linked with the development of thinking. The improvement of sensation, perception and conception is the deepening comprehension of the visually

> presented phenomenon, object or whole situation. The more complex the situation as an object of perception, the stronger is the influence of the developing mechanisms of thinking in re-structuring the child's perceptual knowledge.
> 3) The mastery of words signalizing different relations among the phenomena of the objective world is of particular significance for the development of perceptual activity. This means that the child must master grammatical forms for constructing sentences. Expressed in a grammatically correct sentence, the child's thought gradually becomes an increasingly accurate and complex reflection of reality, of all the diverse connections and relations between the objects and phenomena of nature and society" (Liublinskaya, 1957, p.204).

Luria's emphasis on the importance of language, reflected in his publications (Luria & Yudovich, 1959, Luria, 1961a and b) are reminiscent of the American research on verbal mediation. In the 1959 experiment in the separation and training of the five year old twins, the hypothesis stated was that only with speech could complex intellectual organization occur. The beginnings of the more sophisticated behaviour described by American behaviourists in the reversal learning situation, and by Piaget at the close of the preoperational period have also been documented by Luria:

> "Only between the ages of five-and-a-half and seven do children begin to tackle on their own tasks whose performance involves organizing operations of an imaginative kind: not till much later does it become possible for these same operations to be purely discursive, i.e. based upon verbal reasoning" (Luria, 1961a,p.16).

This later stage alluded to by Luria, and Piaget's adolescent stage of acquisition of formal operations might well lead us to suspect that although the children in the Kendler studies are performing similarly to the adults on reversal shifts, the Kendlers might be oversimplifying the situation if they apply the same mediational model to the data involving children as they do to that of adults. The Kendlers have only studied children up to the age of ten. As has already been mentioned, Osler & Shapiro have reported recently, a change in type of behaviour at almost this age. This will obviously bear further investigation.

The controversy between Piaget and Vygotsky concerning egocentric speech and its function on the young child's thought is not so important as the fact that both investigators agreed that it does exist. Although they concurred on many points, Vygotsky felt that Piaget emphasized the autistic quality of egocentric speech and underrated its social roots:

> "Thought development is determined by language, i.e. by the linguistic tools of thought and by the sociocultural experience of the child. Essentially, the development of inner speech depends on outside factors; the development of logic in the child, as Piaget's studies have shown, is a direct function of his socialized speech. The child's intellectual growth is contingent on his mastering the social means of thought, that is, language" (Vygotsky, 1965, p.51).

Piaget pointed out in his recent Comment (1962) on Vygotsky's book that they would very likely agree on many more points today than they would have in 1930. However, he indicated in relation to Vygotsky's interpretation of socialization and egocentrism,

> "...the word socialization becomes ambiguous in this context: if an individual A mistakenly believes that an individual B thinks the way A does, and if he does not manage to understand the difference between the two points of view, this is, to be sure, social behaviour in the sense that there is contact between the two, but I call such behaviour unadapted from the point of view of intellectual co-operation" (Piaget, 1962, p.8).

For the present study, the mere existence of this early language behaviour offers us clues concerning the nature of the type of mediation hypothesized by the behaviourists to exist in discrimination learning and reversal shift performance.

Conclusion

The examination of the Piagetian and Soviet literature provides considerable enrichment of the findings of experimenters in the behaviourist tradition. Large quantities of theoretical and empirical evidence suggest that even in quite different environmental situations, under vastly different experimental conditions, a qualitative change in problem solving behaviour occurs between the ages of five and seven. This change is essentially one from

stimulus bound, limited cognitive activity toward more flexible concept formation. This is accompanied by an increase in verbal facility which is believed to contribute to the mobility and equilibrium of more mature thought. The fact that the studies in the various traditions seem to have been conducted in quite amazing isolation from each other, adds a measure of credibility. We know with some degree of accuracy that if we present a group of children at about the age of six with a discrimination learning task followed by either a reversal or a nonreversal shift task, approximately half of the children will perform the reversal shift with greater ease, and the other half, will perform the nonreversal shift more easily. This observed phenomenon seems attributable to a change in cognitive functioning in children at this age.

If we were to take any specific child out of that group, could we on the basis of certain kinds of knowledge about him predict whether he might be a "reverser" or a "nonreverser"? Is it possible, in other words, to isolate factors, other than increased chronological age, which are related to the development of the increased cognitive maturity which is assumed to accompany reversal facility? We have some evidence to suggest that level of intellectual

functioning and verbal ability are related to reversal ability. Three factors which have received very little attention in the studies discussed in this chapter, are the effects of sex, motivation, and amount of environmental stimulation on the performance of a reversal learning task. Investigation of these variables seems to be conducted outside the mainstream of experimental and developmental research. The ways in which these three factors affect intellectual performance will be examined in Chapter 2 of this thesis.

Introduction: II

In this chapter I shall discuss some of those factors which have previously been ignored in relation to discrimination shift performance. Research findings concerning the effects of social group background, sex differences, and incentive values on cognitive performance in general provide a framework from which specific hypotheses can be stated and subsequently tested.

Environmental effects on cognitive functions

Piaget acknowledged the importance of a child's environment to his intellectual development. He said,

> "The human being is immersed right from birth in a social environment which affects him just as much as his physical environment... It is...quite evident that social life affects intelligence through the three media of language (signs), the content of interaction (intellectual values), and the values imposed on thought (collective logical or prelogical norms)" (Piaget, 1950, p.156).

What do we know about the environment, and in particular, the social environment of a child maturing in our society? An examination of the material on child rearing practices provides some interesting clues. A factor likely to be of critical importance to a child's cognitive functioning is the nature of his interaction with his parents or caretakers during his first years of life. The time spent with a child, the quality of which would serve to help him develop tools for effective intellectual functioning, should be an

important variable. It might be predicted that a child who has spent a considerable portion of his preschool life in comparatively rich and satisfying interaction with at least one adult, will perform in discrimination learning situations in a more sophisticated way than a child who has not benefited from this type of environmental encouragement and stimulation. As Nisbet, in Family and Environment said,

> "Previous studies...have shown from the testing of children from institutions, of only children and of twins that lack of contact with adults results in retardation of verbal development; and there is substantial evidence here to suggest that ability with words is of importance not only in verbal tests but in all abstract thinking" (Nisbet, 1953, p.17).

It is well to acknowledge early in this discussion that the data on child rearing and on social group membership are both profuse and at times confusing. This is the result of many factors. First, methods of investigation have varied widely from those relying on questionnaires and/or observation, to the experimental studies of more recent date. Methods of inquiry have often been crude and control necessarily weak. Maternal reports, if retrospective, are unavoidably inaccurate, and the problem of social desirability is ever present. Does a mother report what she expects the experimenter wants to hear or what she hopes that she herself did (or did not) do? There are problems in

terminology. One investigator defines permissiveness in terms of oral gratification, another in terms of independence training. We know that quality of behaviour in one area need not be predictive in another area, however. As the indices of behaviour often differ, so do the indices of such independent variables as social group membership. One study reports maternal education, another, the advanced numerology of Warner, Meeker & Eell's Index of Social Class. These measures probably overlap, but they are not entirely comparable With as much variability in the experimental situation as these factors can create, the ideology of the experimenter can have its bearing on his results. Recent research in the social psychology of the experiment should teach us much that will help to make this kind of issue less troublesome.

One additional problem is that of time. There are two effects here. The first is that child rearing practices have been seen to change over time. Generational shifts in child rearing emphasis have been shown by Bronfenbrenner to have confused researchers. That results obtained in the 1950's have conflicted with 1930-40 results possibly reflects a change in child rearing practices. Middle class mothers in the 40's were found to be more restrictive than working class mothers (Davis & Havighurst, 1948) whereas, in the 50's, the reverse was observed to be the case (Sears,

Maccoby & Levin, 1957). Second, without more longitudinal studies, we cannot know if a sample of parental practices at any given time represents the quality of that parent's behaviour toward his child over the two decades or so that he functions in that role. The nature of the relationship of a parent to his child may well alter over time. These problems can only be alluded to here. In spite of them there is much interesting material to examine.

Dawe's early experiment with children demonstrated the effects of environmental enrichment on intellectual functioning. She tested approximately a dozen orphanage children and then, over a period of six months, spent an average of about fifty hours with each child. Stories and poems were read to the children, they were shown pictures, and taken on excursions. Her rationale was as follows:

> "A survey of the literature in the field of language development and intelligence indicates that in young children there is a high relationship between language ability and intelligence and that language ability is more closely related to mental age than to chronological age.
>
> It has also been demonstrated that in measures of language achievement and of mental ability children of upper occupational levels are definitely superior, at least at the younger age levels, to children of lower occupational levels. It was found that certain children living in a very meagre environment were retarded in language ability even for their mental age. There was also evidence to indicate that certain superior environments have been effective in improving scores on tests of language ability and intelligence.

> Attempts to analyze the factors in good environments that are associated with superior language and development have found positive correlations with such items as association with adults, access to books, hearing stories and suitable extensions of the environment through trips and excursions" (Dawe, 1942, p.200).

The vast differences in intellectual functioning of her experimental group after even so short a training period as she gave was encouraging. The effect over time of such early training is not known, however.

Milner's "A study of the relationship between reading readiness in Grade One school children and patterns of parent-child interaction" is a more detailed and perhaps more modest study than Dawe's. It related mothers' reports of interaction with their children to the performance of these children in their first year at school. The problem of the possible discrepancy between maternal reports and actual behaviour (cf. Brodie, 1965) is a real one, but it is likely that it does not negate Milner's findings. Children whose mothers reported that they spent more time with them, talking to them at the dinner table, reading to them etc., were found to be more successful in school. Milner said of them,

> "The high-scoring children are surrounded by a much richer verbal family environment than are low-scoring children: a. they have more books available to them, b. they are read to by personally-important adults more than are low-scoring children.

> The mothers of high scorers are much more likely to be of professional level in education and premarital occupations than the mothers of low scorers. Further, more of the high scorers' mothers are actively engaged in professional or high-level clerical occupations. To what extent the superior linguistic environment which this circumstance represents has affected and affects the current verbal skill of their children is unknown, but it may safely be concluded that the effect must be considerable" (Milner, 1951, pp.107-109).

Milner's indices for assessment included a "language IQ" from the California Test of Mental Maturity; social groups were differentiated by Warner's Index of Social Class (ISC). Even a cautious reading of Milner's finding must allow that the mothers of superior achievers in the first grade reported in common that they spent a great deal of time and effort expanding their children's horizons.

Schulman & Havighurst (1947, p.441) reported a correlation of + .46 between socioeconomic status and vocabulary which they say is "slightly higher than those usually reported for the relationships between socioeconomic status and measurements of intelligence or mental abilities, which usually range from .3 to .4." The well known arguments of such researchers as Havighurst and Davis concerning what they described as the middle class bias of IQ tests involved the claim that they penalize for linguistic defects which are inherent in the working class situation. Davis said (1949, p.78) that the bias of tests is due to "... the overwhelming importance of language including vocabulary

and sentence structure, as these are developed in the culture of the higher socioeconomic groups." This problem has been thoroughly documented (e.g. Havighurst & Breeze, 1947, Haggard, 1954). Since innate ability was not what we were concerned to uncover in our study of discrimination learning, but rather, present intellectual functioning, the problem of test bias need only be touched upon. Binet and Simon were thoroughly conscious of the problem of the effects of environmental inequalities on standardized test performance. They said,

> "...the little children of the upper classes understand better and speak better the language of others. We have also noted that when they begin to compose, their compositions contain expressions and words better chosen than those of poor children. This verbal superiority must certainly come from the family life; the children of the rich are in a superior environment from the point of view of language; they hear a more correct language and one that is more expressive" (Binet & Simon, 1916, p.320)

They comment on another researcher's work,

> "I strongly urge the author to calculate new averages taking account of the state of the poverty or wealth represented by the parents of the children... I suppose that in rich schools, there are fewer children in a class than in the poorer school; and that is, I believe an important condition to note in order to correctly estimate the intellectual development of the child..." (Binet & Simon, 1916, p.324).

The devising and careful assessment of suitable categories for the classification of environmental conditions is as problematic today as it was when Loevinger

discussed it in 1940. Although she demonstrated how crude and unreliable are most sociometric tools, she also substantiated the importance of the dimension whatever the classificatory system used. Her study emphasized the relation between 'socioeconomic factors" and intellectual functioning, but she said,

> "From one point of view, it may be suggested that the very attempt to construct a scale of socioeconomic status involves a 'quantitative fallacy', namely, the notion that all differences are susceptible of linear quantification, which has so stimulated American psychology and has led it into so many premature generalizations" (Loevinger, 1940, p. 165).

She also reminded us that various measures of socioeconomic status yield various correlations with scored IQ:

> "Whether because of unreliability or admixture of irrelevant factors, scales composed of economic, cultural, occupational and educational factors are usually inferior in predictive value to straight measures of parental intelligence or education" (Loevinger, 1940, p.202).

She claimed for this relationship between parental education or intelligence a universality:

> "The degree of relation characteristic of American school children holds approximately for English school children and has been confirmed with remarkable exactitude in a study of Russian school children" (Loevinger, 1940, p.202).

The whole nature-nurture issue, which seems to have been so commonly discussed at that time (e.g. Stoddard & Wellman, 1940) need not concern us. That the following

relationships have been shown to exist is enough. Evidence of a positive relation between a child's scored intelligence and his father's occupation has been produced repeatedly over the years. Haggerty & Nash's very early study (1924) is an excellent example of the careful documentation of correlations between IQ and parental occupation. But the negative relationship between family size and intelligence scores within all social groups which was reported by the Scottish Survey (1953) - along with the report of a positive relation between paternal occupation and IQ - is some indication that the effect of a close contact with an adult is critical to the intellectual development of the child.

A recent experiment by Hess & Shipman (1965) argued that differences in mothers' ability to instruct their children can affect the modes of problem solving of the child. Middle class mothers in this study proved more capable and effective teachers of their children than were working class mothers. The effects of early instruction of this sort on later cognitive functioning needs much further investigation.

More general studies of childrearing offer us some evidence about variations in environmental stimulation. But in these studies, there is often very little specific

investigation of the kinds of home background that have been directly related to cognitive functioning. Studies such as those of Ericson, 1946, 1947; Davis & Havighurst 1946 and Davis, 1949, Maccoby & Gibbs, 1954, Sears, Maccoby & Levin, 1957, and Sears, 1965, Miller & Swanson, 1958, and Kagan & Moss, 1962 provide us with a panorama of views of the American parent in relation to his child, primarily in terms of psychoanalytically derived concerns such as cleanliness training and feeding schedules. Bronfenbrenner's explanation of what appeared to be certain conflicts in the evidence (e.g. White, 1955) derived from these various studies, seems reasonable. The behaviour of the modern mother has changed over time in such matters as the management of the infant's life. These changes have been caused by many things: increasing technological advances have altered many aspects of her job from the advent of the nursing bottle to that of the automatic clothes dryer. Advances in medical knowledge have altered pediatric opinion and thus professional advice on child rearing issues. Bronfenbrenner's survey shed light on the American trends. He said,

> "Class differences in feeding, weaning and toilet training show a clear and consistent trend. From about 1930 till the end of World War II, working-class mothers were uniformly more permissive than those of the middle-class. They were more likely to breast

> feed, to follow a self-demand schedule, to wean the child later both from the breast and bottle and to begin and complete both bowel and bladder training at a later age. After World War II, however, there has been a definite reversal in direction; now it is the middle-class mother who is more permissive in each of the above areas" (Bronfenbrenner, 1958, p.425).

But Bronfenbrenner wrote in the 1950's. More recent evidence suggests that middle class mothers in the 1960's are returning to a position of more control than was the case in the previous decade. It is interesting that in Dr. Spock's 1957 revision he altered many of his sections to call for more parental assertiveness.

In general, however, the middle class mother is described as being concerned for the welfare of her children in a more articulated fashion than is the working class mother. She has at her disposal more time, skill and money to provide a stimulating environment for her children (Waters & Crandall, 1964). The mother who must wash all her children's clothing by hand is not so inclined to encourage a child's exploratory ventures. Freedom to taste the glories of splashing in mud puddles is more likely to come to the child whose mother both assesses positively the virtues of such adventures, can provide frequent changes of clothing and can throw the casualties into a machine (Walters, Connor & Zurich, 1964). The mother of a large family who says that the older children dress the younger

ones because she is too busy tending the house and caring for the current infant probably has very few moments in a day when she can sit down with any one member of her family to read him a story, play a game, or just chat. This does not mean that there is a social group difference in maternal warmth, indeed there is evidence to suggest that there are not social differences on this sort of dimension (Newson & Newson, 1963, e.g.). It simply means that differences exist between social groups in the degree of intellectual stimulation. A fairly recent treatment of this aspect of socialization may be found in Bandura & Walters (1963).

Douglas' 1964 study of The Home and the School, an investigation of factors affecting success in primary schools in Britain, emphasized the importance of parental encouragement (Chapter VII) in academic performance. This aspect of a parent-child relationship is reported to be associated with social group membership, although obviously it did not coincide exactly with it. Deutsch and his colleagues have conducted a great deal of research lately with under-privileged children in America. Their reports include considerable evidence to suggest that a lack of environmental stimulation creates a cumulative deficit in cognitive ability and verbal development (e.g., Deutsch, 1965 and Deutsch & Brown, 1964). Douglas' results support this claim.

There have been few psychological studies specifically designed to investigate child rearing practices in Britain, and generalizations from American data can be tricky to say the least. Study of mother-infant interaction (As in Foss, 1961, 1963) has developed fruitfully. There have been many recent investigations, more sociological in nature, which shed some light on the environmental backgrounds of children from different social groups. Early studies included Faneth (1944) and Spinley (1953), while Young & Willmott (1957), Kerr (1958), Willmott & Young (1960) and Jackson & Marsden (1962) have provided more recent accounts. Klein (1965) draws inferences from such works in her discussion of child rearing practices in Britain. But since the method of many of these studies is worrisome and since none of these investigations was concentrating on obtaining an accurate and balanced picture of the environment of the young child, what we gain is highly impressionistic. Also, there is little concern with the upper regions of the social scale. A few small studies, such as Lynn & Gordon's (1962), are beginning to provide more controlled data on such aspects as permissiveness vs. punitiveness. Lynn & Gordon compared their results with American evidence. Other comparative studies are beginning to appear: Rabbie (1965), Karr & Wesley (1966) and Prothro (1966). These will help to estimate the amount of

generalization that can be made. Studies of British education, such as Floud, Halsey & Martin (1956) and Halsey, Floud & Anderson (1963), provide useful evidence concerning the kinds of environmental differences which are related to intellectual success as reflected at various levels of school performance in Britain.

There is one study of child rearing in Britain which promises to be both extensive and thorough. It is that of the Newsons,[1] in Nottingham, who have started a longitudinal study of mother-child interaction. Their 1963 book reports results of their examination of 700 mothers of one year olds. They are at present preparing for publication their investigation of their subjects at age four as well as carrying out the fieldwork on the mothers now that the children are seven. Some of the results with one year olds are of interest for the purpose of the present study, but many more of the findings with the four year olds will prove relevant in connection with the quality of environment in which the child develops. Information has been gathered by means of tape recorders and verbally administered questionnaires. Although there are the usual dangers, the

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[1] I am grateful to the Newsons for having sent me a copy of their questionnaire to the mothers of the four year olds as well as sharing with me a pre-publication copy of a forthcoming article and a draft of one chapter of their book on the four year olds.

safeguards the Newsons have incorporated and the sensitivity of the questions they ask are most impressive. In an interim report on their research they say,

> "...middle-class style of parental control, as compared with working-class practice, puts greater emphasis on reasoning, arbitration, fairness and politeness. Furthermore, there is a greater stress on good manners, and a more sustained effort to teach children to behave in socially acceptable ways according to a pattern of mutual rights and obligations which the mother continually brings to her child's attention in words and by the conscious example of her own actions. A central theme is the premium which middle-class parents put upon explicit verbal communication with their children, not only for the purpose of checking unwanted behaviour, but in order to sow the seeds of ideas, particularly moral ideas to make them think about their own behaviour and that of other people, and to make them aware of what others might think of them. Reciprocally, middle-class parents are more likely to listen to verbal excuses and to respond to verbal complaints: verbal fluency is thus reinforced at many different points in the middle-class child's every day life" (Newson & Newson, 1966, p.67).

They report the fact that middle class mothers do not threaten their children with punishment (such as withdrawal of love or of action from policemen, teachers or doctors) which they do not mean to carry out. This, according to the Newsons (1965, p.10), "illustrates an attitude of rather scrupulous regard for verbal truth which we believe is characteristic of the educated middle class mother." We must await their book on four year olds tentatively entitled Four Years Old in an Urban Community to see the more complete picture of results concerning English child

rearing practices as the Newsons have found them.

The work of such researchers as Kellmer Pringle furnishes comparative analyses of verbal behaviour of children in "normal" homes and those in institutions (Pringle & Tanner, 1958, Pringle & Bossio, 1958a, 1958b, 1960-61). These studies derive from earlier, more general studies of the effects of institutions on the individual's development, such as those of Skeels, Updegraff, Wellman & Williams (1938) on orphanages, Spitz (1945) on hospitalization and Burlingham & Freud (1944) on homeless children. Kellmer Pringle & Bossio say,

> "The hypothesis that deprived children are markedly backward in language development, is supported by our findings. Moreover, the extent of this backwardness was larger than that found in any other aspect of development and achievement. Thus it seems that the effect of deprivation tends to be most detrimental to a child's language development. It is likely, therefore, that assessing the intelligence of deprived children by predominantly verbal tests, inevitably results in an under statement" (Kellmer Pringle & Bossio, 1958b, p.167).

The extensive literature concerning maternal deprivation (particularly UNESCO, 1949, Bowlby, 1952 & 1960-61, and the World Health Organization, 1962), in spite of methodological problems, leaves the reader with no doubt that an ~~area~~ area of a child's development critically affected by the absence of a

close relationship with a single adult is the sphere of verbal competence.

Clarke & Clarke (1960-61) provide a survey of the literature on early deprivation in its various forms: social isolation, cruelty and neglect, institutional upbringing, adverse child rearing practices, socioeconomic and cultural deprivation, and separation experiences. Ainsworth's careful analysis of the research (1962) involves the suggestion that great care should be taken, in studying maternal deprivation, to discriminate between deprivation which implies <u>insufficiency</u> of interaction, <u>distortion</u> in the character of the interaction and <u>discontinuity</u> of relations caused by separation. These three aspects of deprivation are often confounded. The aspect which relates most directly to the present study is that of insufficiency of interaction.

That damage is caused by all of these forms of deprivation is generally agreed. The areas of harm, their seriousness and depth are yet to be accurately defined. To what extent the damage is reparable is not known. The degree of stability and the developmental stage at which any deprivation of contact might occur probably bear conjointly on the types of deficits incurred. Ethological evidence concerning the importance of critical

periods provides a useful contribution to the discussion. Ainsworth summarizes the evidence concerning the specific processes affected by deprivation as follows:

> "Maternal deprivation has a differential effect on different processes; most vulnerable seem to be certain intellectual processes, especially language and abstraction, and certain aspects of personality, most especially the ability to establish and maintain deep and meaningful interpersonal relations, but also the ability to control impulse in the interest of long-range goals. There is some reason to believe that the age of the child - more accurately, the state of development of the child - has an influence upon the processes affected; thus, for example, it seems reasonable to conclude from present evidence that deprivation during the first year of life affects language and abstract functioning (and indirectly the IQ or DQ) more than does deprivation later on" (Ainsworth, 1962, p.149).

Most studies of deprivation in humans lack experimental control due to the nature of the problem. Auxiliary and most provocative support and amplification of the findings with humans is provided by the Harlow experiments with rhesus monkeys. From such laboratory experiments (e.g. Harlow 1961) clearer hypotheses may be derived concerning the specific effects of deprivation in the emotional, intellectual and social aspects of development.

The recent stream of work by Bernstein (1958, 1959, 1960a, 1960b, 1961, 1962a, 1962b, 1965) provides a sociological approach to linguistic study well worth considering. His theory involves the influence of language

structure on cognitive processes. The differential effects of social group membership on these functions confirm and perhaps explain some of the findings of verbal and intellectual deficiencies existing in poorer environmental situations. He said,

> "The language-use of the middle-class is rich in personal, individual qualifications, and its form implies sets of advanced logical operations; volume and tone and other non-verbal means of expression although important take second place. It is important to realize that initially in the middle-class child's life it is not the number of words or the range of vocabulary which is decisive but the fact that he or she becomes sensitive to a particular form of indirect or mediate expression where the subtle arrangement of words and connections between sentences convey the feeling. It is the latter which the child originally strives to obtain in order to experience a full relationship with the mother and in so doing learns to respond to a particular form of language cues. Because of the importance of this type of mediate relation between mother and child a tension is created between the child and his environment such that there is a need to verbalize his relations in a personal, individual way. Thus the child at an early age becomes sensitive to a form of language-use which is relatively complex and which in turn acts as a dynamic framework upon his or her perception of objects. This mode of language-use [Bernstein calls] <u>formal</u>...
>
> The child in the middle-classes and associative levels grows up in an environment which is finely and extensively controlled: the space, times and social relationships are explicitly regulated within and outside the family group" (Bernstein, 1958, pp.164-166).

Contrasted with the formal quality of the language of the middle classes is the <u>public</u> language, the much more restricted type of communication of the working classes,

> "The individual who is limited to a public language will tend to possess a relatively closed perceptual system. The number of new relationships open to him will be restricted. It follows that there will be a high degree of perceptual rigidity.
>
> He will be oriented towards a relatively low order of conceptualization which will set the limits to the matrix of relationships within which he operates. The Piagetian developmental sequence from concrete to formal operations may not be inevitable in the case of the child restricted to a public language" (Bernstein, 1960a, p.320).

He offers the hypothesis that the limitations of verbal skill which he has documented in the working classes might retard or even prevent the cognitive development of an individual:

> "One important issue concerns the question of reversibility of behaviour regulated by the implications of spoken language. There is little evidence to suppose that the later linguistic change is attempted (i.e. the development from public to formal types of communication), the more difficult it becomes. It is also possible that critical learning at one period prejudices the efficiency of future learning" (Bernstein, 1960a, p.321).

There has not been time for researchers to provide great bodies of evidence either in favour or in disproof of Bernstein's hypothesis. A recent statement by him puts his case clearly and quite cautiously. Bernstein emphasizes the fact that social group membership is an awkward dimension to handle when he says,

> "I should like to draw attention to the relations between social class and the two coding systems. The sub-cultural implications of social class give rise to different socialization procedures. The different

> normative systems create different family-role systems operating with different modes of social control. It is considered that the normative systems associated with the middle class and associated strata are likely to give rise to the modes of an elaborated code whilst those associated with some sections of the working class are likely to create individuals limited to a restricted code. Clearly social class is an extremely crude index for codes... Variations in behaviour found within groups who fall within a particular class (defined in terms of occupation and education) within a mobile society are often very great. It is possible to locate the two codes more precisely by considering the orientation of the family-role system, the mode of social control, and the resultant linguistic relations...
>
> Children socialized within the middle-class and associated strata can be expected to possess both an elaborated and a restricted code, whilst children socialized within some sections of the working-class strata, particularly the lower working-class, can be expected to be limited to a restricted code. If a child is to succeed as he progresses through school, it becomes critical for him to possess, or at least be oriented towards, an elaborated code.
>
> The relative backwardness of lower working-class children may well be a form of culturally induced backwardness transmitted to the child through the implications of the linguistic process. The code the child brings to the school symbolizes his social identity. It relates him to his kin and to his local social relations. The code orients the child progressively towards a pattern of relationships which constitute for the child his psychological reality and this reality is reinforced every time he speaks" (Bernstein, 1965, pp.164-165).

Several intensive studies such as that of Templin with children (1957) provide evidence which is consonant with the analysis of Bernstein.

We seem to have come round full circle. One is reminded of Luria's comment that,

> "...a child's mental activities are conditioned from the very beginning by his social relationships with adults... Age-old human experience is passed on to the child by adults and, or, in man, mastering this experience - in which process the child acquires not only new knowledge but also new modes of behaviour - becomes the main form of the mental development unknown in animals" (Luria, 1961a, p.1).

Some aspects of the present study in the light of its research background

There are enough indications in the literature of the effects of environment on verbal and cognitive abilities to have made it both prudent and interesting to observe three aspects of these: present intellectual functioning, verbal facility, and environmental influences in the present investigation of discrimination shift behaviour. The difficulties involved in gaining some control of these variables are considerable.

Intellectual functioning

The measurement of intellectual functioning in the early school years is not very reliable. It was, however, decided that, in terms of the amount of time spent for the degree of accuracy in estimation achieved, Raven's Progressive Matrices (1947) Sets A, Ab, B would be appropriate. Burk's critical review (1958) of the use of matrices tests pointed out their value in research projects. Martin &

Wiechers (1954) reported correlations of .91, .84, and .83 between matrices scores and the Full Scale, Verbal, and Performance Scale IQ's on the Wechsler Intelligence Scale for Children (WISC). Stacey & Carleton (1955) reported correlations almost as high on the Stanford-Binet Form L with "possible mental defectives" and correlations in the .50's with WISC scores. Walton's study (1955) with older children stated that the Matrices should be administered individually for the best results. Barratt's thorough study (1956) of the relationship between the 1938 Progressive Matrices and the Columbia Mental Maturity Scale and the WISC helps to identify the abilities tapped by Raven's test.

Most investigators have emphasized that many of the disadvantages of the Progressive Matrices are more than balanced by its speed and ease of administration. Harris's fine critique (1959) is based on his comparison of the Matrices with Thurstone's Primary Mental Abilities Test and Goodenough's Draw-A-Man Test. He reported a split-half reliability (corrected) of .466 with kindergarten children; his review was not altogether favourable particularly in terms of the test's standardization. But Yates reported that his study produced results (1961, p.156) which "in general support the claim of Foulds & Raven (1950, p.108) that 'perceptual tests of education appear quite suitable

for eliciting the higher intellectual functions and for assessing superior intellectual efficiency.'" A recent study (Freyburg, 1966) has again found the test a useful nonverbal instrument with young children although doubts about its reliability were voiced.

Verbal facility

A measure for verbal facility was required for use in conjunction with the measure of intellectual functioning. The Vocabulary Subtest of the WISC was selected for a number of reasons. Wechsler has reported (1949) that it is related both to the Verbal Scale IQ ($r = .66$) and to the Full Scale IQ ($r = .63$) in $7\frac{1}{2}$ year olds. Since this vocabulary test is so frequently used by experimenters, it has become a useful comparative measure of verbal fluency despite its flaws. Wallach & Kogan reported using the WISC Vocabulary for very similar reasons (1965, p.38).

Environmental influences

Although there are vast difficulties involved in trying to isolate the type of environment considered by so many researchers to be critical to the development of early verbal and cognitive skills it seemed desirable that some attempt be made to differentiate subjects according to an

estimate, however crude, of their environmental opportunity. In the light of the studies already quoted, the formulation and the assessment of subtle criteria differentiating a stimulating from an unstimulating environment would have been a long term investigation in its own right. Failing such a possibility, it seemed reasonable to expect that children whose parents were, very broadly middle class - i.e. those who had proved themselves capable of competing successfully in a predominantly verbal milieu - first educationally, and then occupationally - would be raised in an environment relatively saturated in verbal content. Not only would these parents strive to enrich their children in their own areas of competence, but they would also teach them to value and cultivate these skills for themselves. The children should, then, have at their disposal at a relatively early age the types of mediational tools critical to such concept formation tasks as are required of them in school situations, and in our experimental problem. Not only would middle class parents be more capable, at least in terms of time and resources, of providing a relatively rich environment for their children, but they would also perceive it as their responsibility as parents. With this in mind, schools were sought which enrolled children from more privileged homes in our society,

The schools termed middle class for the purpose of comparison were fee-charging schools in residential districts of London.

Parents whose living did not depend on verbal competence, i.e., those who had not excelled scholastically and who had consequently been restricted to more manual occupations were judged to be likely on the whole to be less capable of providing the type of environment which would stimulate their children intellectually. Although skills other than those in the verbal-cognitive orbit might well be fostered, those specifically related to symbolic operations would seem likely to be undernourished in working class surroundings. There are of course notable exceptions, but the values involved in the intellectual pursuits of the schools are often at variance with the values inculcated in working class homes. Children whose parents had not been so successful verbally, who themselves had not at an early age been obliged to cope in a highly symbolic environment, would probably not have had at home so much opportunity or encouragement to develop so readily or early, e.g., in the preschool years, the verbal skills necessary for the solution of more complex cognitive problems. In search of children who could reasonably be described as less privileged in environmental stimulation of intellectual

functions, schools in economically depressed areas of London were visited. These schools in what could be called working class districts provided children who could be compared with the middle class children and thus make the environmental variable in some sense observable.

Sex differences in cognitive functions

The common finding that verbally, girls are articulate and fluent at an earlier age than boys was judged relevant to the present research. In fact, its relevance to a number of aspects of cognitive functioning was so clear that sex was selected as an important controlled variable. Davis's 1937 monograph reported female verbal superiority at least up to age nine and a half. As Templin has more recently reported,

> "The general articulation score increases with age until essential maturity in articulation is reached by eight years. Boys take about one year longer than girls, and lower socioeconomic status groups about one year longer than upper socioeconomic groups to attain essentially adult articulation" (Templin, 1957, p.58).

Anastasi has summarized the data on fluency and has hypothesized about causes:

> "Female superiority on verbal or linguistic functions has been noted from infancy to adulthood. This difference is found in almost every aspect of language development that has been studied, and has been reported by different investigators.

> Observations on normal as well as on gifted and feebleminded children have shown that on the average girls begin to talk earlier than boys... Girls likewise begin to use sentences earlier than boys and tend to use longer sentences and more mature sentence structure. In learning to read, girls also make more rapid progress than boys.
>
> Girls reach maturity of articulation at an earlier age than boys... This developmental difference in the motor aspects of speech may provide a clue to the general female superiority in linguistic functions. The acceleration of girls in physical development probably accounts for their more rapid progress in articulation... Another hypothesis for the linguistic advantage of girls is based upon sex differences in amount and nature of contact with the mother, who serves as the principal source of early language training" (Anastasi, 1953, pp. 472-473).

McCarthy (1953) has postulated some possible environmental explanations for the observed female superiority. She said that perhaps mothers chat more freely with girls and are more accepting of their behaviour. In the home, the mother expects and encourages her daughters to share the chores; boys will be sent out to play, to pursue more physical, presumably more masculine (and perhaps less verbal) activities. McCarthy also suggested that girls more easily identify with and imitate a mother's voice, whereas boys are taught from an early age that father is the one they are to emulate. But fathers are not so available nor are their voices so easy to replicate. So opportunity for practice and the emotional tone for this practice both perhaps contribute to the differential success

of boys and girls. Again, in the early years of school girls have suitable models in their female teachers, while the boys are left out.

The nature-nurture aspects of the finding, however, need not detain us longer. The point is that sex differences in verbal behaviour have been reported. Some researchers have not supported the belief in a general verbal superiority, however. Terman and Tyler analyzed the problem as follows:

> "The fact that most of the reading investigations reporting female superiority have been based on speed of reading tests, coupled with the above cited evidence from the primary mental abilities studies that it is fluency rather than verbal meanings in which girls excel, gives us some clue as to a possible reason for the discrepancy between reported results" (Terman & Tyler, 1954, p.1071).

So it may be that girls do better than boys in some aspects of verbal functioning, and boys do better than girls on others. What do factor analyses tell us? Anastasi said,

> "With the more recently developed multiple-factor batteries, it has proved possible to analyze sex differences in verbal functions somewhat more precisely. Studies of high-school age groups with the Thurstone tests of Primary Mental Abilities showed a significant difference in favour of girls in Word Fluency (W), but not in Verbal Comprehension (V), in which sex differences tended to be negligible and inconsistent...it is evident that girls do relatively better in word fluency and in tests involving mastery of the mechanics of language than they do in vocabulary, verbal comprehension and verbal reasoning tests" (Anastasi, 1953, p.474).

The findings of sex differences in the performance of various portions of the Primary Mental Abilities test (Hobson, 1947 and Herzberg & Lepkin, 1954 being only two of many such studies), and the Differential Aptitude Test (e.g. Wesman, 1949) make one very suspicious indeed of studies in any sphere of intellectual functioning which ignore possible sex differences. A recent plea by J.E. Sigel (1965) for the investigation of sex differences in the study of cognitive tests put the case very clearly. He described the sorts of inconsistencies found at present in the literature concerning sex differences and proposed that it is possible that even when group means may be similar, style of performance may differ between the sexes. It may not simply be level of performance that differentiates males from females, but also the patterns of abilities. Finally, he said, that in some instances, "Is it not possible that boys and girls appear to behave similarly, but for different reasons?"(p.365).

Differential effects of incentives on cognitive functions

A common omission in much of the research with discrimination learning or concept attainment experiments has been the careful investigation of the effects of various types of incentives on task performance. The examination of the effects of rewards seems often to be executed outside

the mainstream of research with important tasks, since in order to control for reward effectiveness problem tasks are often kept extremely simple and mechanical (Witryol & Fischer, 1960). The research which has been carried out with children, however, does indicate that much of the variability in performance in simple tasks is caused by variations in reward. Bijou & Sturges (1959) reviewed the research up to that time and strongly advised research workers to exercise more effective control of motivation in this area. The suitability of rewards is known to be particularly important for good performance in very young children. Differences have been found in the relative effectiveness of various rewards with different types of subjects.

Terrell and his associates (Terrell & Kennedy, 1957, Terrell, 1958, and Terrell, Durkin & Wiesley, 1959) have reported that distinct variations in transposition learning performance were related to the presence of different rewards. For instance, Terrell & Kennedy (1957) offered five different types of incentive for performance: verbal praise, a small sweet, verbal reproof, a delayed small sweet, or a light flash. The immediate small sweet was significantly more effective; the delayed sweets followed closely behind. Subjects were four to five year old and eight to nine year old children. Terrell (1958) using

promise, token, and immediate material rewards (sweets) again tested four to five and eight to nine year olds. This time token rewards (with concrete rewards, sweets, given upon achievement of criterion) proved as effective as immediate rewards. Promise rewards were least effective.

At this point in the programme of research, Terrell observed that there seemed to be some effect from social group membership which was causing discrepancies between the two sets of experimental results with reward effectiveness. So another experiment was designed (Terrell, Durkin & Wiesley, 1959). They divided their subjects (according to Warner, Meeker & Eells 1949 scale) into two social groups, and assigned half of each group to a material, and half to a nonmaterial condition. All children were given a simple task to perform and results were analyzed in terms of experimental group membership. They reported that concrete material rewards enhance the performance of working class children, whereas more abstract rewards which simply convey a knowledge of correctness seem to be effective motivation for middle class children. Their subjects were children aged five, six, ten, and eleven years old.

These experimenters suggested that their rather simple experimental technique was revealing variations in the constellations of values which these children were learning at home. They suggested that middle class children rather

early in life are taught that certain activities have their own intrinsic value, and that accuracy is important for its own sake; whereas working class children tend to be taught that this is a life of the here and now and that one should strive for the attainable. Douvan (1956) reported similar results with adolescents. Both middle and working class responded well to material rewards but for nonmaterial rewards middle class children's strivings remained the same while working class children did considerably worse.

Terrell, Durkin & Wiesley said,

> "Several interesting implications arise from this experiment. There is evidence to indicate that parents of middle-class children place a greater emphasis on learning for learning's sake than do parents of lower-class children... It would appear that the most important feature in the learning of middle-class Ss, is merely some indication that they are progressing. It is strikingly apparent...however, that the presence of a material incentive is very important to lower-class Ss. It is possible that the lower-class child is too preoccupied with obtaining the material, day-to-day necessities of life to have the opportunities to learn the value of less material, symbolic incentives" (Terrell, Durkin & Wiesley, 1959, p. 271).

The same sorts of results were obtained in a study of Canadian school children by the writer (Cameron, 1964). Middle class children performed a discrimination task more effectively for nonmaterial than material rewards, while North American Indian and white working class children performed better for material than nonmaterial incentives.

Under material conditions all three social groups performed the same.

Consonant with these findings are the studies of Stevenson & Snyder, 1960, Zigler & Kanzer, 1962, and McCoy & Zigler, 1965. The children in Zigler & Kanzer's study were rewarded either by being praised for performing correctly, or by being told they were correct. The children's performance led these researchers to conclude,

> "...praise reinforcers are more effective for lower- than for middle-class children, while correct reinforcers are more effective for middle- than for lower-class children.
>
> This finding would appear to have both practical and theoretical import. It suggests that in experimental work with children care must be taken to employ verbal reinforcers that are optimal for the particular type of child investigated. As was found with tangible reinforcers (Brackbill & Jack, 1958) such a procedure should decrease the variance in children's performance beneath that found when some particular verbal reinforcer is arbitrarily employed for all children. The findings of this study also suggest that studies which purport to demonstrate cognitive differences between various types of children may actually be demonstrating the differential effectiveness of the reinforcer employed" (Zigler & Kanzer, 1962, pp. 160-161).

Simply from the practical point of view it would seem important, particularly with young subjects, to provide optimally appealing incentives. The Brackbill & Jack (1958) study mentioned by Zigler & Kanzer will be discussed in detail later. They presented a practical suggestion for reducing the variation within experimental groups by

attempting to ensure that the value of rewards be equivalent for all subjects. If, for instance, several types of material reward were offered and the subject asked to choose the one he wanted to work for, the value of that reward for him might well be closer to the value placed by another child on his chosen reward than if only one kind of material reward were available for all subjects.

Zigler & Kanzer postulated a developmental progression of incentive effectiveness to account for their results:

> "The concept of a developmentally changing reinforcement hierarchy may also be applied to the findings of this study. As has been suggested by other researchers the effectiveness of attention and praise as reinforcers diminishes with maturity, being replaced by the reinforcement inherent in the information that one is correct. This latter type of reinforcer appears to serve primarily as a cue for the administration of self-reinforcement. This process is central to the child's progress from dependency to independence.
>
> This thinking applied to the present study suggests that the lower-class seven-year-old child is developmentally lower than the seven-year-old middle-class child in that he has not made the transition in which reinforcers signifying correct replace praise reinforcers in the reinforcer hierarchy. Some support for this argument may be found in recent work which indicates that social class transcends economic and social considerations and reflects the global level of development attained. Related to this argument is the suggestion... that the lower-class child is less influenced than the middle-class child by abstract, symbolic rewards. Such would be the case if the lower-class child were indeed developmentally lower than the middle-class child of the same CA" (1962, p.161).

Recent studies designed to replicate these experiments and to develop the hypothesis of a hierarchy of reward values have not, however, confirmed the Zigler & Kanzer findings. Rosenhan & Greenwall (1965) and McGrade (1966), following Zigler & Kanzer, found that the developmental predictions made by Zigler & Kanzer simply did not hold with their experimental groups.

McGrade tested a large group of boys (N = 288): 96 each in the kindergarten, second, and fourth grades. The children were divided, using the Warner, Meeker & Eells scale, into four social groups. Several variations were made within the correctness-praise-verbal reinforcement dimensions. The experimenter was unaware of the hypothesis of the study. No interactions were obtained between either reinforcers and social class or reinforcers and age. Rosenhan & Greenwall also failed to obtain an interaction between reinforcers and social class, although they did obtain a small effect from the age by reinforcer interaction. Two very important suggestions were made by McGrade. In the first place, her experimenter was naive. In all of the previous studies, the authors who served as their own experimenters had systematic expectations concerning the effects of the incentives they were using. Bias would inevitably be reduced in McGrade's study, but at this point in our knowledge of the social psychology of the

experimental situation we do not know in what way or to what extent this sort of bias operates. The second issue raised by McGrade also involved the experimenter. It would seem that an experimenter similar to a child's family may have one type of effect on his responses and an experimenter perceived to be different, quite a different effect. This suggestion could have some bearing on the study reported in this thesis.

The importance of using incentives which are appropriate to a particular group of subjects is specially great with very young subjects whose attention span is short and whose motivation to perform well might be weak. There has been little empirical work done on the differences in reward effectiveness between sexes, or between children of different intelligence. Nor do we know much about variations in the suitability of various incentives with children of different chronological ages. Experiments such as McGrade's and that of Meyer & Seidman (1960) have posed more questions than they have answered concerning the developmental trends in motivation.

Although the present study was not specifically designed to examine reward effects, subjects were assigned either to material or to nonmaterial reward groups. It was hoped that although these are very crude classifications, they would provide some measure of control of the subjects'

motivation and they would also allow an opportunity to observe any interactions which might occur between sex, scored IQ or social group membership with reward condition. Within the two reward conditions subjects were allowed to choose the specific rewards for which they were to work. Children who were assigned to the material reward condition were allowed to choose between performing for small sweets (Rowntree's Smarties) or little silver coloured trinkets, material rewards commonly reported to be of high incentive value for young children. Children in the nonmaterial incentive groups were asked to choose whether they would rather perform for a bell tinkle or a light flash. These latter sorts of incentive, commonly used in experiments of this sort, are believed to be rather highly symbolic knowledge of correctness cues. They are most effective in a situation in which the performance of the task itself is somehow intrinsically rewarding. So the dichotomy material-nonmaterial was intended to reveal differences in the intrinsic vs. extrinsic sorts of motivation and the choices within those classifications were intended to control the value of the rewards within the classifications for the individual children.

Delay of gratification

Finally, a reward choice was given to each subject following the experimental learning task. This choice technique has been shown to discriminate between groups of children on issues related to the ability to delay an immediate gratification in order to obtain a larger reward at a future time. The issue of reward choices supplements and should clarify the discussion of incentive values.

The relation between the experimental evidence concerning reward effectiveness and task performance already discussed, and the delayed versus immediate reward choice procedure can be understood most clearly in the light of the research on achievement motivation (n Achievement) which has been conducted during the last fifteen years. Many investigators have referred to an achievement syndrome which seems to involve the ability to work for rather abstract, long range goals in preference to concrete or immediate rewards.

Achievement motivation has been extensively studied since McClelland, Atkinson, Clark & Lowell published The Achievement Motive in 1953. Expansions of the theory (the most important of which include: French, 1955; Atkinson, 1958; Rosen, 1958, 1959; and McClelland's own follow-up study, 1961) emphasize that an individual's home environment is critical in the development both of the ability to

"work for work's sake", and of the willingness to delay present gratification in order to achieve a more substantial reward in the future. As Douvan says,

> "The middle class child is urged to individual achievement, is compared to his age mates by his parents, and is taught to respond to symbolic as well as material rewards. He develops, accordingly, strong, and well-internalized desires for accomplishment, and responds consistently to success-failure cues even when achievement offers little or no substantial reward. The working class child, on the other hand, is not pressed for individual attainment as early, or as consistently, and his motivation to succeed in a given task is more clearly related to the rewards such success entails" (Douvan, 1956, p.222).

Investigators of achievement motivation stress that such motivational training is learned at a very early age, particularly in middle class North American homes, from close contact with adult models. Lipsit & Bendix (1959) also see these forces as a source of upward mobility. It is claimed in these studies, too, that not only in the family, but also in the schools, with their abstract grading systems and rewards (cf. Wilson, 1959) the middle class ethos of reward delay, so sensitively described by Max Weber in The Protestant Ethic and the Spirit of Capitalism, is reinforced. Many independent studies, such as those of Kohn (1959aand 1959b) in the United States, Argyle & Robinson (1962) in Britain and Cameron & Storm (1965) in Canada, lend support to the evidence that n Achievement is a useful construct for the investigation in our western culture of social group membership and motivation. The

educational implication, at all levels of schooling, of this type of finding have been discussed at length in both Britain and America (e.g. Stephenson, 1958, and Halmos, 1963).

Achievement motivation has been found to relate to a subject's perception of and concern about time. In a study of psychological time Meade (1966) has found that subjects who obtained high scores on n Achievement techniques showed a correspondingly great concern with progress and the value of time. This finding seems to relate to an individual's ability to delay gratification in the hope of greater eventual rewards, also found to be characteristic of individuals who display aspects of the achievement syndrome.

A procedure developed specifically to explore a child's ability to delay reward has been used with many different groups of children. Subjects are asked to choose between taking a rather small reward immediately (Im R), e.g., a sixpenny chocolate bar, or a larger one after a certain time has elapsed (Del R), e.g., a shilling chocolate bar in one week's time. There have been many variations in the rewards offered and in the length of delays required. Mischel, the originator of the technique, has reported (1958) that the ability to delay gratification in West Indian children between the ages of seven and nine was significantly related to their age and the presence of a father in the home. It has also been related (1961a) to n Achievement

and acquiescence in eleven to fourteen year olds. The presence of a father in the home (male experimenters were used; 1961b) was significantly related to preference for delay in eight to nine year olds, but not in eleven to fourteen year olds. Social responsibility was also related to delay preference in twelve to fourteen year olds (1961c). Accuracy of time estimation has also been related to ability to delay. No sex differences were discovered.

With American children (Mischel & Metzner, 1962) it was found that increased intelligence and chronological age accompanied increased preference for a delayed over an immediate reward. There was a relationship as well between preference and length of delay. A significant difference in the results obtained from different experimenters supported Mahrer's finding that the experimental manipulation of incentive values in young children is extremely sensitive to differences in the behaviour of the experimenter. Finally, concerning the age trends, they said (Mischel & Metzner, 1962, p.429) "the major changes occurred at the age of 8.5 - 9, between the third and fourth grades. The change from a preponderance of Im R (immediate but smaller reward) choices came at this point, and there was some evidence that the effect of delay intervals of differing lengths was significant above this age only."

Further explorations with American children (Mischel & Gilligan, 1964; Mischel & Staub, 1965; and Bandura & Mischel, 1965) have served to expand the original finding: certain types of children can be predicted to be more capable than others of choosing a delayed reward. Melikian (1959) replicated Mischel's findings with Palestinian Arab refugee children between the ages of five and ten. Mischel used the Freudian concept of "super ego control" to help to explain his findings (he refers back to studies by Singer, 1955; Singer, Wilensky & McCraven, 1956; Spivack, Levine & Sprigle, 1959; and Levine, Spivack & Wight, 1959 in order to identify the concept). He also drew upon Mahrer (1956) and his emphasis on the subject's expectations in relation to their ability to delay and Mowrer & Ullman's 1945 study of time as a factor in mature activity. Such Piagetian studies as Grigsby's which investigates the young child's concept of time (1932) should be of help in analyzing delaying preferences. Farnham-Diggory's recent monograph (1966) on "Self, Future, and Time", includes Mischel's technique among others. She reported that her psychotic subjects chose very few delayed rewards. Delay of reward as manipulated in experimental task situations offers little to our analysis at present (cf. Renner's excellent review, 1964) although in future research, as Renner says, the two

approaches should be analyzed as complementary manifestations of a significant motivational structure within each human subject.

Children in the present experiment were given a reward choice as a complement to the reward conditions within the main design. Each child chose between taking a sixpenny chocolate bar that same day or a shilling bar in a week's time.

Summary

It was reasonable to expect that such factors as we have been discussing would have some impact upon reversal learning. The present research was designed to examine the effects upon discrimination and reversal tasks of age, scored IQ, and verbal fluency as well as of sex, social group background and reward condition. A five-way analysis of variance design permitted an inspection both of the effects of these variables, and of their interactions. In this fashion we were able to discover whether a group of English children at six years of age, like Swiss, American and Soviet children, are in a transitional period in their cognitive development, i.e., whether half of them perform the reversal shift more easily, and the other half, the nonreversal shift.

The following general predictions were made. Subjects

between the ages of five and a half and six and a half should as a group perform the two types of shift with equal ease, although members of certain experimental subgroups within the total sample should reverse more easily, and others should perform the nonreversal task more easily. Verbal fluency should accompany discrimination facility in general, and perhaps reversal learning specifically. Children who scored well on the IQ measure should perform the reversals best and low IQ scorers should perform the nonreversal shift best. If girls attain verbal and cognitive skills earlier than boys, perhaps they would be more sophisticated in their shift performance at this age. Boys might still be in the nonreversing stage. If environmental stimulation could be estimated from broad indications of social group membership, those less stimulated intellectually, i.e., working class children should still be in the nonreversal phase and middle class children might have advanced to the reversing stage. As with shift condition, there was no basis for predicting that one reward would be more effective than another for the group as a whole at age six. We did, however, have reason to predict that the effects of incentive variations would interact with one or more of the other variables, for example, social group or intelligence. High IQ and middle class children from older age groups

tend to prefer delayed, larger rewards. At the age of six, the differences between groups should be considerably smaller, but any existing differences should be in the same direction: not many working class or low IQ children would be likely to choose a greater reward later in preference to an immediate, smaller reward.

Against the background of research thus summarized, and with these predictions in mind a study was planned and carried out. The method and procedures adopted are described in the next two chapters.

Method

Preliminary work

Two projects conducted before the present one helped to some extent to develop the techniques used here. The first exploratory study was conducted in Vancouver, Canada in 1963. Various aspects of this research have been reported (Cameron, 1964; Storm & Cameron, 1964; and Cameron and Storm, 1965). Children from three Canadian subcultural groups performed a discrimination learning task for which they were differentially rewarded. All subjects were given an abbreviated version of McClelland's need for achievement projective test. Each child was also asked to choose between taking a large reward in a week's time, or a smaller one immediately. The study was designed to investigate the effects of different types of rewards on the discrimination learning performance of the members of various social groups. The material from the n Achievement and reward choice techniques was intended as supplementary material.

Subjects, ranging in age from six to thirteen years, included twenty-two North American Indian boys attending the two schools visited. All the Indian children within this age range lived on a nearby Indian Reservation. These children were matched for age and school placement with two

other groups of boys: one a white middle class group defined solely in terms of their fathers' occupations and therefore termed white collar, and the other, a group of twenty-two white children whose fathers were manual workers, the blue collar group. The families of the Indian children were distinctly less privileged in economic terms than those of either of the white groups, the Reserve fathers being on the whole unskilled workers, both seasonally employed and frequently jobless.

The discrimination task involved the simultaneous presentation of two stimulus cards, each of which consisted of a complex multicoloured design made from bits of coloured paper cut in different shapes and glued in asymmetrical patterns, some overlapping and some not, on a white background. One card in each of the stimulus pairs contained four green stars in its design. The choice of the card with the four green stars constituted a correct response. Each correct response was rewarded. Fifty trials were given. The task was constructed with a view to its suitability for the rather broad age-range of children to be tested and was itself pretested for developmental difficulty. Subjects were assigned at random, within their subcultural groups, to one of two reward conditions. Half of the subjects worked for sweets which were classified as material rewards.

The other half worked for a nonmaterial reward, a light flash which was intended simply to communicate to the subject that he had discriminated correctly. There were thus six experimental groups, each containing eleven subjects. Scores on the last ten trials, i.e. from trial 40 to trial 50 were reported (Cameron, 1964, p.18) as in Table 1 in Appendix A.

A two-way analysis of variance of the scores showed the effect of subculture to be significant at the .05 level. Since the interaction between subculture and incentive condition was also significant this effect required further examination. Table 2 in Appendix A (from Cameron, 1964, p.17) shows the results of the analysis of variance. The results of the subsequent t tests showed the white collar subjects to perform better than the other two groups only under the nonmaterial reward condition. The comparisons of the differences in performance means for nonmaterial rewards yielded a t equal to 3.055 ($df = 20$; $p < .01$) for white collar vs. blue collar groups; the white collar vs. Indian comparison was as follows: $t = 4.126$ ($df = 20$; $p < .01$). All other comparisons were nonsignificant.

The results of the n Achievement protocol and of the reward choices augmented the main results. Middle class children exhibited both a significantly larger number of

achievement themes and a greater preference for larger delayed rewards than did the other two groups. Indian children told the fewest achievement-related stories and chose the most immediate rewards. The white working class children appeared to be intermediate between the other two groups in all three experimental situations. Limited and imperfect as this study was, it did serve as an excellent exploratory venture.

A second smaller study was conducted in London during the spring of 1965. The children tested all attended a small independent school in Fulham. They ranged in age from almost five to almost twelve; 45 children were tested in all. A new learning task was tried. This project was intended simply as a means for examining and improving an entirely new procedure. New experimental equipment was constructed to specification by the Science Workshop and the laboratory technicians of the Psychology Department at Bedford College. Its effectiveness was examined along with intelligence test and discrimination task instructions, reward techniques and the like. Instructions were particularly closely observed in order to discover whether the young English children could understand, or at least respond appropriately to the experimenter's Canadian accent and phrasing. Raven's Coloured Progressive Matrices Sets A, Ab, B were administered to each child (N = 45) along with

the Vocabulary Subtest of the Wechsler Intelligence Scale for Children (1949). An attempt was made to find the most appropriate mode of standardized administration for all the proposed techniques. Special attention was given to the applicability of the tasks for the youngest children. It was decided that a composite score from the Raven and Wechsler tests could be used in the subsequent larger study in order to classify, for experimental purposes, each subject as either high or normal on the intellectual functioning dimension. The WISC scores proved difficult to divide or combine with the Raven, however, so the IQ classifications in the main study referred only to Raven scores. The WISC scores were held for use in an analysis of covariance. (The high-normal designations were used in order to avoid distressing school officials who might object to a "low IQ" description of their pupils).

The experimental task involved initial training on a simple discrimination problem and a subsequent shift in responses in the manner described at the beginning of the first introductory chapter. Children were assigned at random to either a reversal or a nonreversal shift group. Half of the children were rewarded for each correct response by material incentives (either trinkets or Smarties) and the other half by nonmaterial rewards (light flashes or bell tinkles). The effects of these experimental conditions could

be observed in a very impressionistic way, but with a sample so small the effects of such proposed variables as sex could not be observed. Also, although it was expected that there would be a mixture of social groups in the school, it was actually quite thoroughly a middle class community. Consequently there was no opportunity to look for hints of differences on that dimension. Age differences could, however, be observed.

A summary table of findings is given in Table 3 (Appendix A). For a number of reasons these findings were not statistically analyzed. First, since the purpose of the study was to examine techniques, standards and methods of administration varied from child to child and therefore control was not suitably maintained for subsequent analysis to be meaningful. Also, the sample was very small, there was a large age span and a large number of variables were involved. Nevertheless, certain trends emerged which were viewed as promising. Even though the discrimination learning task was examined primarily for its suitability for infant school children, it was felt that some indication of an age trend in performance skill could be seen. The Mischel reward choice was given and the predicted age trend in delay preference was observed. Also, a difference in shift performance between younger and older children was evident.

The experimental techniques were in this way analyzed and modified where it appeared advisable. The very co-operative environment produced by the headmaster and staff helped the experimenter to gain both confidence and speed in administering the tasks. Since the school is a "model" school directed by Montessori instructors, both staff and students were accustomed to the frequent disruptions which school visitors inevitably create. The experience was extremely encouraging.

With these two studies as a background, the main study was designed.

Subjects

The sample was drawn from four schools in various areas in London, which were visited in the following order. The first was a Roman Catholic school in Mill Hill; the second, the independent Montessori school in Fulham that was previously used for the pilot work; the third, a state school in South Acton which was under the direction of the Middlesex County Council; and the fourth, a Roman Catholic school in Tower Hill which was classified as "cooperating" with the Inner London Education Authority. All infants in the first forms of these schools were examined on as many

measures as possible. It was only after the entire experiment was completed that the final sample of children was selected for a five-way factorial analysis of discrimination learning task performance. So long as a child could be seen to be very broadly within predetermined limits, (see p.109 of this chapter) a normal English infant school child of approximately five and one half years of age had as good a chance of being selected for the final sample as any other child tested. All children were being taught by teachers who had some training in Montessori teaching method and all were in their first year at school, but had been attending classes for several months before they were tested.

The children attending the Fulham school came very broadly from middle class homes. Fathers were professional men or business proprietors and the families of the children tended to be geographically mobile. Children from several foreign countries were attending the school and the atmosphere was quite cosmopolitan. On the whole the children were members of small families. In this school fees were charged and classes were small. Physically the school was somewhat cramped since it was housed in a large old house, and a paved back garden constituted the playground.

The children at Mill Hill seemed to be a more

homogeneous group. Classes were somewhat larger, but since classrooms were much more spacious, they were also much less cramped. Since this is a suburban school, the grounds, too, were more extensive. Again, fees were paid. The children here, too, were middle class, although there seemed to be a wider occupational range among the parents. There were professional fathers, some entertainers in TV and theatre, shop proprietors and company secretaries. It could be that the economic standards of some of the children here were somewhat lower than those of most of the children in Fulham, but being in the suburbs it is likely that the children enjoyed more space at home as well as at school than did the Fulham children. The school was populated almost exclusively by English children and they seemed to live in a relatively stable environment.

The South Acton school was located in a working class residential district. Children attending the school came from what appeared to be two districtly different groups. There was a large number of foreign, and particularly coloured children. These children were tested, but excluded from analysis for the obvious reasons that language handicaps and/or cultural differences were likely to confound the effects of the experimental variables. The parents and grandparents of the English children in the school were

longstanding residents of that area. Many parents had attended the same infant school as their children. The economic standards of the families of this section of the sample appeared distinctly lower than those of the Fulham or Mill Hill groups. Classes were still larger and the rooms ~~even~~ much more crowded. There were no school fees and no school uniform.

The school in Tower Hill was different again. In the centre of the industrial east end of London, and near the Thames dock area, this school had a population of children from large families living in extremely crowded surroundings. Apart from a certain stable proportion of Irish children, and a new relatively small influx of Maltese people, the population was predominantly English. Some families had been rehoused in council dwellings, but many families continued to live in grossly deteriorated buildings. Classes were large in the school and facilities perhaps most limited of all.

Selection of the final sample

The test results of certain children were excluded from the final randomized sample on the following grounds:

1. if English was not their native language.

2. if they had any serious sensory defect such as sight or hearing loss.

3. if the teacher mentioned them as having a gross psychological or behavioural problem and if they subsequently were difficult to test. There were diagnosed epileptics and autistic children in the school populations. If they were difficult to test then their scores were not included in the final sample.

4. if they were coloured. This referred primarily to the West Indian children in South Acton.

5. if a child had just started school and was reported by the teacher not to be settled in yet. It was left to the discretion of the teacher to decide how these children were to be handled. Sometimes a teacher would advise that the child not be tested since she felt the situation would be difficult for him to cope with. But sometimes it was recommended that the child be tested even if it was expected that he or she might not be capable of following instructions yet. In either case, such a child's score was excluded from the final sample.

6. if they did not perform to criterion within sixty trials on either learning task.

7. if they exceeded age limits, that is, if they were under five or over six and a half.

8. if there was a severe interruption in the testing procedure. In several cases teachers entered the testing

room out of curiosity. Testing was continued as it was felt that a teacher had a right to watch the testing in progress, but the subject's performances on these occasions were excluded from the final analysis.

Altogether 277 children were seen of whom 208 did all the tasks, and 69 made only the reward choice. These latter 69 children, in classrooms adjacent to those of the main sample, were either a little younger or older than the subjects required. They were children who were keenly aware that the experiment was in progress and were eager to participate. Their teachers were cooperative and so although the reward choices in these cases were given without the other procedures, ages were noted and it was hoped that some developmental evidence might emerge from this additional information which would illuminate the findings with the main sample.

The remaining group of 208 children represented all the members of the classes from which subjects were drawn. It was agreed by the teachers that once a few children in a class had been selected for testing, classroom disruption would be minimized if the entire group were tested. Children at that age are distressed at the thought of being left out, and this way a teacher was able to gain some control by promising that all children would have a turn in good time.

Of the scores obtained by the children who did all the tasks, those of nineteen were discarded on the basis of the predetermined criteria listed above. Control of the experimental variables was therefore relatively good, considering the age of the subjects and the variety of testing environments. From the remaining 189 sets of scores, 128 were selected to fill the 32 cells of the factorial design, four to a cell. The mean age of this group of 128 children was five years, ten months and its range was between five years, three months and six years five months. The distribution of subjects by school attendance is shown in Table 3.

The schools were selected to maximize socioeconomic differences. In the absence of better criteria, schools were chosen in different areas of London where abundant differences in housing, open space, parental occupation, and the like could be observed.[1] School attendance was decided upon as a global criterion for social group membership.

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[1] In a study of this sort, only a very sketchy and impressionistic report of the environmental factors impinging on the school situation is possible. Teachers in all schools were most generous with their time in discussing most thoughtfully with me the problems of their academic situation, the types of homes from which their pupils came, and the effects of these factors on the children themselves.

Although there appeared to be a difference in economic level and living conditions between the Tower Hill and South Acton sections of the group, both were designated working class for the purpose of this study. The differences seem to have been balanced by similar variations between the two middle class groups. A far greater difference was apparent, however, between the two major social divisions: there was a considerable gap between Fulham and Mill Hill on the one hand and South Acton and Tower Hill on the other. We are comparing here extremes on this social dimension. The middle class children came from the higher economic regions of that classification and their environment seemed on the whole, more privileged than the average for middle class children. There were few lower middle class subjects in the sample, in other words. In contrast, there were also few upper working class children in the working class population. The subjects appeared to tend to the less privileged economic levels, and the environments of the children were similarly impoverished. This fact should be remembered when the factor of social group membership is examined in later analyses. The scored IQ variable, in contrast, was distributed along a continuous scale. Subjects scored along the entire continuum, and in fact, the majority scored very near the average, or point of central tendency with

relatively few subjects representing the extremes of that dimension.

Since subjects for the entire experiment were recruited through contact with teachers trained at the Montessori Training Centre in London, there was a certain degree of similarity in approach toward their teaching tasks between teachers. Also, much teaching equipment was the same in all classrooms. The major observable difference between social groups seemed to be in the areas of space and amount of equipment.

Apparatus and materials

The main portion of the experiment involved the use of a rather large piece of equipment. It was a grey-green box 24 x 24 x 11 inches, which was placed on any convenient table. Subjects (Ss) were seated in front of the box and shown how it worked. Plate 1 shows the front of the equipment. The experimenter (E) sat behind the equipment while trials were in progress. The back of the box opened out so that E was able to control stimulus presentation, score a S's performance and dispense rewards. The inside of the equipment can be seen in Plate 2. During the actual execution of the learning task, the S could not see E. This was intended to minimize social interaction so that the reward conditions could be controlled.

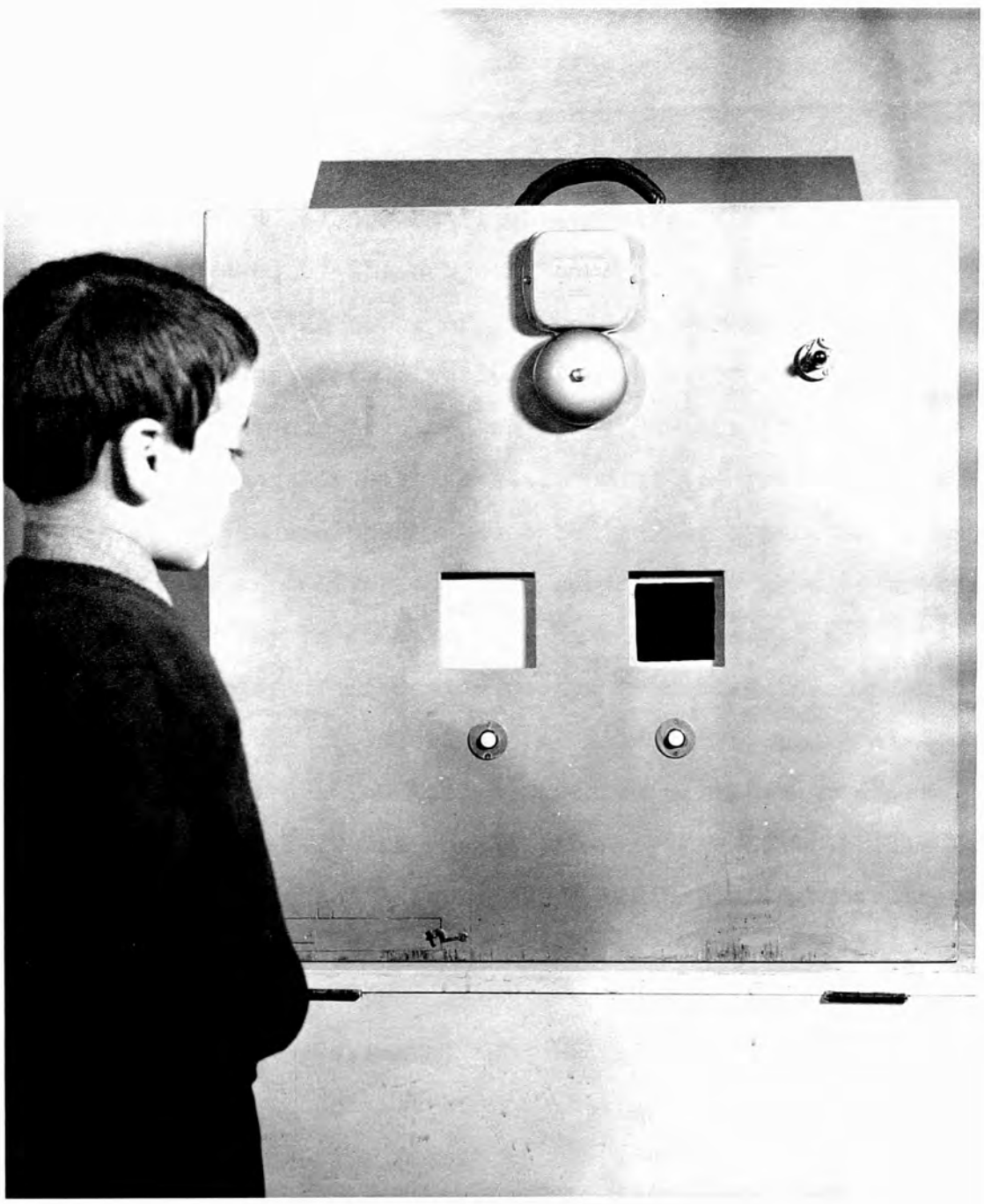

Plate 1

The front of the box facing the child contained two square holes or windows which were shuttered between trials. The windows were 3 x 3 inches, 3 inches apart, and approximately at the child's eye level. (See Plate 1). Beneath the windows were small white buttons, one of which was to be pressed by the subject in order to indicate his response choice. When one of the buttons was pressed, it flashed on a light inside the box. This light indicated to E which stimulus has been chosen by S. At the bottom of the box was a rectangular opening situated at the base of a chute within the equipment. From behind the apparatus rewards could be delivered to the subject through this chute. A flat metal tray in front of the opening received the material rewards. This device seemed to reduce the temptation for the children to play with the rewards between trials, but it did allow the children to watch their store of rewards increase. The possibility of this distracting them will be discussed later. Above and between the stimulus windows was fixed a bell and a small red light bulb was mounted on its left. The bell and the light were manipulated by E by means of buttons inside the box. A tinkle or a flash constituted a nonmaterial reward.

The stimuli that appeared in the windows were large

(2½-inch squares) or small (¾-inch squares), coloured either black or white on a grey background. These squares and their backgrounds were painted serially onto long rolls of strong white paper 3½-inches wide (See Plate 2). Each stimulus pair that a S saw in any one trial consisted of one square in each window; these squares alternated in size and colour. The various combinations were presented in a prearranged random order. In the shift task, stimuli were paired so that on one presentation they differed on just one stimulus dimension, size or colour but not both. This adaptation minimized the confusing effect of unintended intermittent reinforcement of the initial task's correct response. For example, if a S were initially rewarded for responding positively to white, and if he had been placed in a reversal shift experimental group the stimulus pairs in the discrimination shift problem would be of uniform size (either large or small) only brightness would be varied. This adaptation was suggested by Buss (1953) and has been used in subsequent similar research by Kelleher, the Kendlers and others. A coding system on the back of the stimulus rolls (Plate 2) provided a rapid and easy method of scoring.

Although rewards were classified as either material or nonmaterial, and half of each of the experimental groups

Plate 2

were assigned to one of these two reward conditions, subjects within each classification were allowed to choose between two specific incentives. As indicated in Chapter II (pp.90-1) material reward children could work either for small candy covered chocolate sweets called "Smarties" made by the Rowntree Company. These sweets are multicoloured and are very popular with children. The alternative for children in the material reward groups were small plastic trinkets in various appealing shapes: little telephones, scissors, jack-knives, kettles and so forth. The trinkets were silver coloured and could be put on a string. They were obtained at a price of £4/3/9 per thousand from Seagull Products, Egremont, Cumberland. Children assigned to the nonmaterial reward groups were asked to decide whether they would prefer to be told that they had made a correct response by means of a light flash or by the ring of the bell. The light was flashed on by E for two seconds to indicate that a correct response had been made. It was not a particularly dramatic device, but many Ss chose it in preference to the bell which was loud and jangling and seemed to frighten the more timid children. The bell was popular, however, with more adventuresome children. The reward choices seemed to offer real alternatives and motivation seemed very high in most subjects. The method

of reward choice within a particular dimension followed the suggestion of Brackbill and Jack (1958). Any means for reducing the within-groups variability that is often a problem with young children, seemed worth attempting. It was hoped that a reward choice of this kind would help to even out the subjective value of the rewards within a certain classification of incentives. All subjects had to some extent an opportunity to decide upon their own goal.

Each child was tested on the book form of Raven's coloured Progressive Matrices (1947), Sets A, Ab, & B; and on the Vocabulary Subtest of the Wechsler Intelligence Scale for Children (1949). Standard substitutions appropriate to an English sample were made for various items on the WISC. The prescribed score sheets were used for both these tests. Score sheets were designed for the tasks which were coordinated with markings on the backs of the stimulus rolls. This way, responses could be recorded very rapidly simply by the stroke of a pencil. No mark was made when there was an incorrect response. Recording ease was very important as E was simultaneously involved with dispensing rewards and altering the stimuli. It was on these score sheets that auxiliary notes were made, and reward choices were recorded.

The technique for further examining reward preference

involved the use of a large number of chocolate bars. Experience has shown Cadbury's milk chocolate to have wide appeal. The two sizes used were sixpenny and one shilling bars.

Experimental design

Five dichotomous variables were analyzed in relation to the successful performance of the discrimination tasks set. Criterion was nine out of ten responses to the correct stimulus and scores were based on the number of trials taken before criterion was reached. The effects of Matrices IQ, sex, social group membership as well as the type of reward offered and the type of discrimination required could all contribute to the variability to be observed. Consequently a five-way (2^5) factorial design was planned.

Children were grouped according to their sex. All children in the Mill Hill and Fulham schools were called middle class and those at South Acton and Tower Hill were classified working class. On the basis of their performance on the Progressive Matrices, children were divided into a normal and a high scoring group. Each child was assigned at random either to a material or to a nonmaterial reward condition, and to a reversal or a nonreversal shift group. Ultimately, thirty-two groups were assembled under the headings shown in Table 4. Analyses by means of the chi-square technique were planned for the reward choices.

Procedure

The experimental conditions in each school were made as similar to each other as possible. The experimenter spent as much time in each classroom before beginning the experiment as each teacher appeared to be willing to tolerate. Care was taken to describe in as much detail as the teachers sought the purpose and procedures of the study. It took approximately one month in each school to test all subjects (Ss) and during that time, the experimenter (E) became a relatively stable figure in the school environment. Testing was done only in the mornings.

In Mill Hill and Fulham, the schools with comparatively large classrooms for the numbers of children attending, the first protocol, the Raven test, was administered to each child at a low table in the back of his classroom. A number of considerations made this procedure desirable in these schools and impossible in the others. First, the teachers in both of these middle class schools' were particularly eager that the children become familiar with E before going away to another room with her, and they were not distressed by the presence of an observer in their classes. The more informal seating arrangements along with the spaciousness of the classrooms made the presence of a visitor less of an obstacle to the classes' smooth progress in these

schools than would have been the case in the working class schools. These surroundings provided relaxed conditions under which the Raven could be given. In Fulham, the childrens' empty lunchroom was used for the rest of the tests, and in Mill Hill, the main portion of the experimental work was conducted in a room normally used by the headmistress to interview visitors.

In South Acton and Tower Hill crowding was severe. At least partly due to the space problems the teachers and children faced, the atmospheres were more restrictive and there was resistance from the teachers to the suggestion that any of the procedures be attempted in the classrooms. The teachers said that the children were accustomed to being asked to go with strange school officials to do different things and they believed that the children would not find such things extraordinary or distressing. Children in the South Acton school were taken to the teachers' empty staffroom for all portions of the procedure and the children at Tower Hill were examined in the school's music room which was situated between the two infant classrooms to which the experimental children belonged.

In all schools, and after the initial introductory period, children were chosen for testing by their teacher in the order that suited her best, so as least to disturb her classroom activities. All children were given the same

sequence of tasks. First, Raven's Progressive Matrices were administered to all the children in a class, one by one. This test took approximately ten minutes for each child. It was scored immediately, and according to certain cut-off points, Ss were assigned either to a normal or a high scoring group. Children within six-month age groups were compared; a median score was determined for each group. These medians, which fell at the 75th percentile points reported in Raven's standardization group, served as the cut-off points. So children above the 75th percentile were called the high IQ group, and those below, the normal group. As has already been said, the Raven test was used because of its speed and ease of administration. Subjects seemed almost universally to enjoy performing it. A longer, more reliable test seemed superfluous since it was needed only to divide subjects into two groups, and since even much longer tests do not contribute a great deal in the way of reliability or validity with children at this age. The instructions suggested in the manual did not always seem adequately standardized. For instance, at one point it is recommended that the psychologist, regardless of the child's response, shall say "Is that the right one?" This seemed to confuse some of the children who had chosen correctly. Perhaps this is only a flaw with very young children, but this and other minor adjustments could make some difference to a final

score. Harris (1959) mentions these same problems in his review of the test.

After the Raven test, each child was given the Vocabulary Subtest of the WISC. It should be emphasized that this vocabulary test was chosen almost by default. Although well standardized as a subtest for American children, its appropriateness as a solitary indication of verbal facility with English children can certainly be questioned. But for children between five and six years of age, there appear to be few better scales. The 1960 Stanford-Binet, for instance, has no vocabulary test at this age. The Picture Vocabulary is intended for children up to five and the main Vocabulary test starts at the six year level. Even for young children, however, the WISC Vocabulary is reported by Wechsler (1949) to correlate well with the total Verbal Scale, and it is quickly and easily administered.

The vocabulary did seem to be a comparatively unpleasant task for some subjects. Obviously, many children enjoyed the challenge of the task and liked the opportunity of spending some time talking with the experimenter. On the whole, however, working class children found the vocabulary trying. As one little girl said (using one of the words she had been unable to define when she was given it in the test), "I didn't like that so much. It is a <u>nuisance</u>, isn't it?"

In an attempt to counteract this feeling in the children, E said to each S after he had finished the Vocabulary Subtest, "Next time you come here to help me I will have a game for you to play which you will really like." Some of the difficulty of the vocabulary might be attributed to complications created by E's accent. The test took more fluent children approximately ten minutes to do. Less verbal children took less time.

An attempt to score the protocols immediately after their performance proved unsatisfactory. It became evident very early that reliability in scoring would be most difficult to maintain if all the vocabularies were not scored at the same time. Also, the first classes of Ss did not obtain scores readily susceptible to any feasible division. As expected, there were considerable differences between responses of children in the middle class schools and those of children in the other two. The scores from this test were, therefore, retained for use in an analysis of covariance design.

By the time Ss were required to perform on the learning tasks, they had spent about twenty minutes with E, and had become quite used to her. It was usually not possible to begin testing on the task until E had been at a school for

several weeks. Under ideal conditions (which quite obviously seldom existed) approximately ten or twelve children could be tested on one of the tasks during one school morning. But interruptions for assemblies, concert rehearsals and the like were common and it was considered wise never to withdraw a S from his class when anything interesting or out of the ordinary was happening. Usually by the end of the first week of testing it was possible to place the children in a class into their IQ group categories. With knowledge of Raven performance, sex, and social group membership, three of the five variables were determined. It was at this point that each subject was assigned at random to the other two variable treatments, those of incentive condition and type of discrimination shift required, and the cells of the factorial design were gradually filled.

So the final and most important stage of the research came when the child was brought to the experimental room for the third time. He was shown the experimental equipment and instructed about its use. E said,

> "This is a game we are going to play, (name of S), but first, I want you to choose how you will find out if you are right or not when you play the game."

If a subject was in the nonmaterial reward group, E continued,

> "Would you like me to flash this light like this when you play, or shall I ring this bell like this?"

If the S was in the material incentive group, E said,

> "This is a game we are going to play, (name of S), but first I want you to choose the kind of prizes you want to try to win. Would you like to get some Smarties like this, or would you rather try to get some little toys like these?"

E gave these instructions while standing beside the S, showing him the various rewards available. When S had made his reward choice, E continued,

> "Fine: here we go then. Listen carefully and I will tell you how to play the game. Look, there are two picture here."

E opened the shutters of the windows and pointed to the squares showing through the openings,

> "When we start the game, you will choose one of them. Which ever one you choose, you press the button right underneath it like this, or like this."

E demonstrated, and continued,

> "If you choose the right one, you will ('see the light flash'/'hear the bell ring'/'get a Smartie'/'get a little toy', depending on the reward condition). If you are wrong, nothing will happen, but I want to see how many ('lights'/'bells'/'Smarties'/or 'toys') you can get. Each time you may choose only one picture and when you do, remember, you press the button under it. After you have chosen, the windows will close, like this and you will have another turn. The game is to see if you can get a ('light'/'bell'/'Smartie'/'toy') every time you choose. Let's try one now, Look at the pictures carefully."

After a choice was made, if S made a correct choice,

> "That's the right one, and see there's the ('light'/'bell'/'Smartie'/ or 'toy')."

If S was wrong, E said,

> "It's the other one, (name of S). Look at that one. Now let's try another one. See if you can get the right one this time."

At the end of the next trial, correct or incorrect response evoked, E said,

> "Go ahead now, let's see how many you can get right."

The task has already been described in the first introductory chapter. As soon as S began to respond E sat down behind the apparatus in order to be able to score responses on the predesigned score sheet mentioned previously. The stimulus pairs were altered between trials almost simultaneously with the reward distribution. Verbal communication was discouraged. One quarter of the subjects were trained initially on each of the four possible dimensions (black, white, small, or large). When they had learned the initial task to a criterion of nine right responses out of ten trials in succession, either a reversal or a nonreversal shift was required. No explicit instructions were given to the subject to alter his responses. There was , however, a pause in which E said,

> "Very good! Now just wait a moment. I have some more for you to do."

This interruption, desirable in any case for maintaining morale, was made necessary by the method of stimulus presentation used. There were thirty stimulus pairs painted on a roll for the training task, and thirty for the shift. If more were needed for either task, E turned the roll backwards and thus had another thirty pairs at her disposal. The portion of the roll yet unused at the point of criterion had to be passed by in order to place the prearranged shift sequence behind the window opening. This probably signalled that a change in procedure was approaching. When the stimuli were properly set, E said,

> "Now, go ahead with these. Which is the right one?"

Following the point at which criterion (again, 9 correct out of 10 responses) was reached on the discrimination shift, S was told,

> "You have done very well indeed. Look."

S's rewards were collected together and placed in a paper bag which was already labelled with the child's name.

If the child had been in the nonmaterial reward condition, he was told,

> "You have done very well. Here are some prizes for you. Would you like some Smarties or some of these little toys?"

A handful of the chosen rewards was placed in a labelled paper bag for the child. It seemed important that all children

should have had some concrete rewards by the end of the procedure.

Finally, each child was told,

> "You have really helped me a lot, you know. First you did all those patterns in my book, didn't you? Then you told me about all those words, and now today you have worked hard on this game. All this has been a great help to me. I should like to give you a present for helping me so much. I have with me today one of these (indicating the shilling chocolate bar) and a lot of those (showing the sixpenny bar). Next week I will bring a lot of these (shilling bar indicated). You can have which-ever one you want; either one of these today (indicating sixpenny bar) or if you will wait till next week, one of these (showing shilling bar) then. One of these now or one of these later."

When S had chosen his chocolate bar, E said,

> "Now I will put this in this bag with your little prizes. It has your name on it and your teacher will give it to you right after school. Just one more thing. If you talk about all the things we have done here to the children who haven't had a turn yet, you will spoil it for them and for me. So I would like you to promise not to tell anyone what we have done until everyone has had a turn. Can you promise? Will this be our secret?"

The rewards were saved until after school so that they would not create a disturbance in the classroom. No technique was started until it was apparent that a whole class of children could be run through on it relatively briskly, and thus intersubject communication held in some check. Actually, the problem of communication between subjects was relatively slight with children at this age.

Previous research indicated (and the present study supports this) that infants and older children are fairly reliable on this point. The children who seem to be unable to resist talking about their experiences seem to be the eight to ten year olds. In this study, the only kind of communication which seemed to occur (and even this seemed to be gratifyingly infrequent) was related to the rewards. There were apparently no slips concerning the stimuli in the discrimination task. What the "right answer" was seemed lost in a flurry of reward choices. Teachers were told that the children were being asked not to talk about the experiment and they were helpful in this regard stopping chats before they got started and mentioning any slips they heard to E.

A few evaluative or critical comments should be made concerning the techniques and procedures used. First, as has been mentioned, the instructions for the Raven Progressive Matrices, are not satisfactorily standardized. It is difficult to administer this test to a large group of children in an adequately uniform fashion. Attempting to present the test fairly to all Ss was important but difficult. The scoring was, however, readily done and obviously satisfactorily objective. Since the median cut-off points for the normal - high dichotomy were

determined after only two middle class schools had been visited, it was fortunate that they were as appropriate to the working class schools as they indeed were. Half of the working class children also obtained scores above the 75th percentile. Evidence in the literature that this test is relatively culture free seemed substantiated in the present work. Obviously there were some differences in the distributions of scores between the two social groups. The range of scores in the top half of the distribution was considerably greater in the middle class groups, as was the range of scores of the working class children in the lower half of the distribution. However, in pure numbers there was the same number of children above and below the medians in each social group. One category which was slightly under represented was that of high scoring working class girls.

The WISC Vocabulary Subtest is much more open to criticism. There were no problems here with administration, but scoring seemed exceedingly difficult. It was difficult to determine firm criteria for scoring, until all responses had been collected. This difficulty may partly have resulted from the cultural gap between the experimenter (a Canadian) and the subjects, and partly it must be due to the fact that this vocabulary was not originally standardized with English children. But it also resulted

from the fact that the scoring system as originally designed leaves a good deal to be desired. The difference between a zero score and a borderline one is extremely subjective.

When the final sample had been selected, as rigid criteria as possible were decided for each word. These criteria were established after all responses of all subjects were considered. They were uniformly employed, so that any scoring injustices were at least commonly imposed on all 128 children in the final sample. The resulting distribution of scores, and their scaled equivalents will be discussed later. The curve of the distribution is so smooth and symmetrical that only Wechsler would have had the faith to predict it.

Wechsler's instruction to disregard mode of expression in scoring seems unrealistic. Since it is flexibility of verbal manipulation that is necessary if the child is to obtain two marks for an answer, he has either to express a complete and coherent description, which takes grammatical skill, or he has to be fluent with conjunctive expressions and appropriate synonyms. These skills are just the sort that working class children so often lack and they are highly related to mode of expression.

The instructions for the experimental task were not entirely explicit. This allowed considerable scope for

exploratory responses at the beginning of the task. They were however, rapidly acted upon by Ss; the task was perhaps self-teaching. Comparison of mean trials to criterion in this study with those of other children in similar experiments showed performance to be very good indeed.

Motivation appeared, generally speaking, to be well controlled in all experimental groups. The physical task of indicating response choice was perhaps a little difficult for the smallest children as it required a fairly strong pressure on the button, which seemed to prove trying for the very young children with relatively weak fingers. On the whole, though, the children performed the task with great enthusiasm.

The high degree of interest and motivation that was maintained throughout the experiment probably existed for the following reasons: a) the children seemed to enjoy the individual attention they were being given, b) they seemed to appreciate the opportunity to miss a few minutes of classroom time, and c) each task provided some challenge, and much greater reward than is usual in the school setting.

The results which were obtained are reported in the next chapter and discussed in the following one.

Results

The following abbreviations are used throughout the discussion of the results:

I refers to Raven score, the scored IQ variable.

S indicates the sex dichotomy.

G refers to social group.

R is reward condition.

Sh is used for the shift problem in discrimination learning.

T refers to speed of learning on the training task. The dichotomized values of each of these variables are indicated thus:

I is divided into H and N, indicating high and normal scores.

S is represented by males and females: Ma or Fe.

G becomes Wk or Md for working or middle class social groups.

R is either M or $\breve{M}$, for material or nonmaterial reward condition.

Sh can be either R or $\breve{R}$: reversal or nonreversal shifts

T is either Q, quick, or S, slow in training task performance.

All Tables are gathered together in Appendix A, and all Figures, i.e., graphs, charts, etc., in Appendix B.

The learning task

It will be recalled that the scores of a sample of 128 children were selected for analysis. The distributions of raw scores on the training task and discrimination shift for the group as a whole can be seen in Figures 3 and 4 in Appendix B. Scores represent the number of trials taken before criterion was reached. Both distributions were positively skewed. The mean score for the total group on the training task was 8.5. The median was 5, and the mode, 5. The range of scores was zero to 52. On the discrimination shift, reversal and nonreversal shifts taken together, the mean score decreased to 6.47, the median remained at 5, and the mode was 2. The range of scores on the shifts was between zero and 35.

In order to prepare these skewed distributions for a factorial analysis, a $\sqrt{X + .5}$ transformation was applied to the raw data. The distributions of the transformed scores are drawn in Figure 5 and Figure 6. The transformation procedure seemed to cause little distortion of the data other than to reduce the extent of the skew, so the transformed scores are used in all subsequent analyses. Comparisons can be made of the totals and means of the transformed scores on both tasks for the main experimental groups by examining Table 6 in Appendix A.

A five-way analysis of variance was calculated for the scores obtained on the training task. The results of this analysis are presented in Table 7. The effects of the variables can be seen to have a very minor influence on the performance of the children at this point in the experiment. The lack of interaction effects was promising. The one significant main effect is that of social group membership. Working class children took significantly longer to learn the training task than did middle class children. These results do not stand on their own, but they do fit in with subsequent analyses and take on a minor degree of interest in relation to them. The training task can perhaps best be viewed as a warming up exercise.

The 2^5 factorial analysis of the discrimination shift transformed scores produced some very interesting results indeed. Table 8 shows the results of that analysis. The influence of each of the main effects on the variability of the group as a whole was as had been predicted. There were significant results related to intelligence as scored on the Raven test, sex, and social group membership. The significant first order interactions between the variables, must be examined first, however, before we can state clearly the effects of those variables. The reward condition and type of shift main effects were not significant, but these two factors interacted in a meaningful fashion with other variables.

G x Sh. This was the most powerful and most important interaction. It is drawn in Figure 7. Working class children performed the nonreversal shift much better than they did the reversal shift. The middle class children performed the reversal shift better than the nonreversal one. The level of difficulty of the nonreversal shift was relatively similar for both social groups, but the reversal shift was much more difficult for working class than it was for middle class subjects. This finding confirms one of the major predictions of this study.

S x G. Although girls seemed in general to perform both shifts more readily than boys, this significant interaction between sex and social group (see Figure 8), shows the greatest advantage to be in favour of middle class girls. Although middle class boys also do somewhat better than either working class boys or girls, it is the middle class girls who are clearly advanced in the skill. This interaction will be referred to below in relation to the I x S effect.

I x R. In Figure 9 we observe the only effect involving the incentive condition variable. The performance of the brightest children can be seen to be clearly enhanced by material rewards, whereas those who did not score well on the Raven test seemed to be handicapped by that type of incentive. There was no real difference in the two IQ groups' performances for nonmaterial rewards. It was as if the less

able children did not have in their power the range of performance potential that the brighter children did, and consequently the presence of material rewards could do nothing to heighten their performance over that attained in the nonmaterial condition: this possibility emerged even more persuasively in the covariance analysis. It is possible that the material reward condition created a more complex stimulus situation which served to confuse duller subjects. We will return to such speculations in the Discussion section of the thesis.

I x S. The girls can be seen once again (Figure 10) to be performing very well. Only boys in the high scoring IQ group approached the good performance of the girls. Boys in the lower intelligence group performed much more poorly than girls in general or than high IQ boys. We can see here the sex effect common both to this and to the S x G interaction. Girls in general performed better than boys, but middle class and high IQ girls had a particular edge on good performance.

An attempt was made to check the Kendlers' finding that the children who perform the training task most successfully are the ones who also most readily perform the reversal shift. Ss in each of the 32 cells were divided into two groups. The two children with the highest scores

on the training task within each cell were termed slow learners (S) and the two with the lowest scores were classified as quick learners (Q). This breakdown prepared the data for a 2^6 factorial analysis of variance. This analysis (Table 9) provided no evidence to support the expectation that speed of learning on the training task, as defined by the Q - S dichotomy had any relation to either improved performance on one or other type of shift, or on any of the other variables. The findings of the 2^5 analysis were simply reiterated here.

A summary table (Table 10), presenting the transformed scores for each subject on both the training task and the discrimination shift, along with the scaled score representing his score on the WISC Vocabulary is provided for reference purposes.

The WISC Vocabulary Subtest

The range of scores on the WISC Vocabulary was from zero to 34. The median was 17, the mean, 17.67, and the mode, 14. The raw scores were transformed to scaled scores, using the standards in Wechsler's Manual. These scaled scores ranged from 1 to 19. For the total sample, the modal score was 13, the median 11, and the mean, 10.63. The distribution of scaled scores was quite satisfyingly normal in appearance.

These scaled scores were used in all calculations as they removed any age effect which might have existed.

Totals and means of the scaled scores for the critical experimental groups are presented in Table 11. A 2^3 factorial analysis was calculated to test the effects of these three variables (I, S and G). The results of this analysis can be seen in Table 12. The significant interaction between I and S is plotted in Figure 11. First, although there is little difference in girls' scores between IQ groups, boys who scored high on the Raven did exceedingly well on the WISC, and boys who did poorly on the Raven also scored badly on the WISC. The general relationship between WISC and Raven scores which can be seen in Figure 11 is apparently a reflection of the strong I main effect. The more prominent main effect, if we can go back to Table 12, which has no interacting aspects to complicate the picture, is that of social group. Middle class children, regardless of sex or intelligence, obtained very significantly higher vocabulary scores than did working class children. Since the standardization of the WISC involved the removal of sex differences, it is not surprising that there was no variability at all caused by the main effect of sex. It is interesting, however, to find that this aspect of the standardization did hold with English children.

The analysis of covariance

In view of the results of the analysis of variance computed for the discrimination shift task, and in particular the G x Sh interaction, it was decided that an analysis of the covariance between shift performance and vocabulary attainment might well clarify the relationship between discrimination learning and verbal facility. At least some of the responsibility for the effects of the variability observed was expected to be attributed to the type of verbal ability measured by the WISC vocabulary. In order to prepare the WISC scores for the covariance analysis, they were subjected to the 2^5 variance design used for the shift task. The results, reported in Table 13 can be regarded largely as a replication of Table 12. The fact that the effects of R and Sh were again nonsignificant in reassuring as it would seem that those experimental groups were balanced on the verbal dimension. The two second order interactions can safely be ignored since their power is quite small and they add nothing new to the analysis.

The results of the five-way analysis of covariance are somewhat surprising. Because of a very strong relation ($r = .65$) within cells between the WISC (the "X variable") and the task (the "Y variable"), there were vast increases in the significance of the chosen variables. The effect of

the elimination of the variability due to verbal fluency seemed to involve the reduction of within cells variation. The general picture revealed by the original analysis remained relatively unaltered (ref. Table 8). While I, S, and G showed large significant effects, R and Sh remained nonsignificant. The first order interactions showed a very similar pattern to those of the previous analysis of the discrimination task. There were in addition, however, several significant second-order interactions. Fortunately there were no significant third or fourth order interactions. Table 15 summarizes a comparison of the significant results of the original analysis with those of the covariance analysis. It will be useful during this discussion to keep it in mind as it abbreviates the two tables of results, Tables 8 and 14 now under consideration.

The second order interactions of the covariance analysis were examined first. The means of the groups on the shift task were adjusted according to the formula:

$$\bar{Y}' = \bar{Y} - b(\bar{X} - \bar{\bar{X}}) \text{ where } b = \frac{E_{xy}}{E_{xx}} = -.2211$$

The adjustments were made for each set of means represented in the significant second order interactions. Tables 16 to 20 record these adjustments for the following interactions: G x R x Sh, S x R X Sh, S x G x R, I x R x Sh, and I x S x Sh.

These adjusted means were used to plot the graphs in Figures 12 to 19. Observation of these five interactions indicated that the first three, although statistically significant are only very mildly so. The effects of the lower order interactions predominated. For example, in the G x R x Sh effect (see Figures 12 and 13) it is the social group by shift interaction which is evident; the effect of reward condition seems very minor. It seems that the process of equalizing the groups in terms of vocabulary reduced the error term to such an extent that the variance ratios resulting from it appeared more significant than they perhaps actually were. This embarrassment of riches necessitated some form of selectivity if the results were to be interpreted meaningfully. It was decided therefore to ignore the effects in this analysis which failed to reach a significance level of .001. The following effects were consequently examined: I x R x Sh, I x S x Sh, G x Sh, and S x G.

I x R x Sh. First, it is interesting to notice that one effect of adjusting the means of the experimental groups in this interaction was greatly to reduce the main effect of intelligence. Whereas the sum of mean scores for normal IQ children in the original data ($\xi \bar{Y}_w$) was 10.335 and the sum for the high IQ subjects was 8.950 (this is derived from

Table 19 by adding together the appropriate mean values), the adjusted IQ group mean score totals were: $\leq \bar{Y}'_N = 9.499$ and $\leq \bar{Y}'_H = 9.786$. The elimination of the effect of verbal fluency as measured by the WISC Vocabulary seems to have eliminated the gross effect of the Raven groupings here. This type of alteration was expected from the covariance analysis.

As can be seen in Figures 17 and 18, the interaction between intelligence and reward remained after adjustments were computed. These figures can be compared with the I x R interaction revealed in the original analysis (Figure 9). Children in high IQ groups continued to excel in their performance for material rewards. The high IQ children showed more variability in their responses for different rewards on both shift tasks, but particularly on the nonreversal shifts. Children in normal IQ groups continued to do slightly better for nonmaterial than for material rewards. The interaction between intelligence and reward was modified by shift conditions. On reversal shifts the I x R interaction was mild, but on nonreversal shifts, the interaction was considerably attenuated. If the nonreversal shift can be seen as the easier task, generally speaking, then it might be expected that there would be more variability in childrens' performance of it.

I x S x Sh. This interaction clearly reveals the profound effect of the sex variable even after the means had been adjusted (see Table 20). In all experimental groups girls performed better than boys, as can be seen in Figure 19. Under both intelligence groupings the females scored best, although the differences were greater with the normal IQ children; this can be interpreted as verification of that finding in the initial analysis (Figure 10).

The S x Sh aspect of the interaction shows that although boys did worse than girls on both shifts, they performed the nonreversal shift a little better ($\Sigma \bar{Y}'_{Ma.R} = 5.317$) than they did the reversal shift ($\Sigma \bar{Y}'_{Ma.R} = 5.553$). The girls, in contrast, did the reversal shift ($\Sigma \bar{Y}'_{Fe.R} = 3.800$) much better than they did the nonreversal shift ($\Sigma \bar{Y}'_{Fe.R} = 4.616$). The effect of intelligence alone once again was seen to be slight after adjustments were made.

G x Sh. The adjustment of the means for this interaction are shown in Table 21. It can be seen that the adjustments served to reduce the effect of social group membership. The sum of the original means was 5.411 for working class children and 4.231 for middle class children, whereas after adjustment, the sum of means for working class children was 4.986 and for middle class children was 4.656.

In this aspect too the elimination of the effect of verbal fluency seemed to have had a predictable effect. But the powerful G x Sh interaction remained clearly evident, as can be seen in Figure 20. As was seen in the original analysis (Figure 7), working class children performed the nonreversal shift much better than the reversal shift, and middle class children performed the reversal shift better than the nonreversal shift. That this interaction was not reduced by the covariance technique would indicate that the abilities which separate these two social groups on this task are perhaps not predominantly verbal in nature.

S x G. The interaction between sex and social group is plotted in Figure 21. Once again girls are seen to be performing well, but here, as in the initial analysis (Figure 8), it was the middle class girls who did exceedingly well. There was little difference in the working class groups, but in the middle class the performance of females was greatly superior to that of the males. The effects of the adjustments to this interaction was to strengthen its impact.

This concludes the report on the analysis of covariance. These results require discussion. Such issues as the possible developmental implications of the finding that ease of performing certain types of shift interacts with

social group membership will be discussed. If middle class children perform reversal shifts more readily at the age of six is this evidence for the developmental sophistication of middle class children? There are hints of an interaction between sex and the type of shift performed with ease, as well as findings that sex differences can only be discussed meaningfully if they are seen in relation to social group membership and intelligence. The interaction between reward condition and intelligence requires examination. These findings must be seen in the light of other research findings if they are to be adequately clarified, and this will be the task of the Discussion.

The reward choice

It was originally planned that analysis of the immediate (Im R) versus delayed (Del R) reward choice would involve only the randomized sample of 128. As the number of subjects not included in the analysis was so very large, however, and since there was no theoretical or methodological reason for excluding the additional subjects, most reward choices were ultimately analyzed from a number of points of view including age differences.

Table 23 shows the choices of the group of 128 selected

for the analysis of variance plan. χ^2 tests for differences related to the three relevant experimental variables, I, S, and C, revealed only one significant result . The social group variable produced a χ^2 value of 2.79. Since a one tailed test of significance is appropriate in this case, the effect of social group being previously predicted, the result was just barely significant at the .05 level of confidence ($P_{.05} = 2.71$). Middle class children were slightly more likely to choose delayed rewards than were working class children. This finding looked promising, but far from conclusive, so it was decided that it would be wise to increase the numbers in the analysis.

The choices of the 80 children who were tested on all procedures, but who were subsequently not included in the final sample, were examined. These choices were analyzed separately simply to be sure that bias would not be introduced by expanding the sample. The choices of these children are reported in Table 24. Analysis of these choices revealed the effect of IQ score on reward choice ($\chi^2 = 4.26$; $p<.05$ using a two-tailed test). Social group produced no effect. From this group of 80 children the same 19 children who were excluded on the basis of the prearranged categories such as language, etc., were once again rejected from further consideration. The choices of the remaining 61 Ss are shown in Table 25.

Once again in order to check for bias, χ^2 procedures were calculated for the variables in question. The social group variable produced a χ^2 of 1.85 which is between the 5 and 10% levels of significance in a one-tailed test, the IQ variable produced a χ^2 of 10.80 which is significant at the 0.01 level with a two-tailed test. Sex again showed no effect. There seemed to be no reason against combining these 61 children with the 128 children in the randomized sample to produce a total of 189 children. Table 26 reports the totals for this group. Analysis of these totals produce a χ^2 of 4.45 for the effect of social group, which is significant at the 5% level of confidence (using a one-tailed test). The effect of scored IQ yielded a χ^2 of 4.28 which is significant at the .05 level even if we are prudent and use a two-tailed test for this variable. Finally, the relationship between sex and reward choice remains nonsignificant. So we may say with some degree of confidence that middle class children tend to choose delayed rewards more frequently than do working class children <u>at this age</u>. We can say with somewhat less confidence, that high IQ children tend to choose more delayed rewards than do lower IQ children.

The choices of the 69 children mentioned previously as having been given only the reward choice will be examined only as an auxiliary indication of possible trends. Since

sample numbers were extremely small, and the children were young, few statistical effects were expected.

1. A group of thirty second form working class children were given the reward choice (Table 27). The range of ages was between six and eight years. In spite of the fact that the range was relatively small, an age effect approached significance at the 0.05 level of confidence. The χ^2 value was 2.22; $p < 0.10$; $df = 1$. There was no sex effect .

2. A group of four to five year olds and a group of children over seven were compared (Table 28). These were children in the first and third forms of a middle class school. There were 23 children in these groups. No statistical effects emerged either for age or for sex by social group.

By combining groups 1 and 2 above, a group of 53 subjects was assembled. Although no reliance can be put on these results, there was in fact a significant χ^2 result indicating a relationship between age and reward choice. Older children more often chose delayed rewards ($\chi^2 = 2.74$; $p < 0.05$ for 1 df). Sex and social group membership produced no effect on reward choice.

3. The reward choices of sixteen third and fifth form middle class children are presented in Table 29. No age, sex, or IQ effects were evident.

This group was combined with the twenty-three subjects in group 2. This group of 39 children displayed a highly significant age by choice effect ($\chi^2 = 9.34$; $p < 0.01$). The other variables proved nonsignificant.

In general these results on the reward choice confirm the predictions which would be made from Mischel's material.

Discussion

A few comments on the design of this experiment should qualify the final discussion of the findings. The advantages of the method included the fact that it provided a context for comparisons with previous research. Since the phenomenon of reversal behaviour has had intensive experimental investigation in America, and complementary exploration in both Piagetian and Soviet analyses, greater security existed for making generalizations about the experimental variables which were examined here. It was encouraging to know that the developmental stage which the behaviourists had encountered coincided with the observations of psychologists quite independent of S-R methodology. The interesting characteristics of the reversal performance of young children do not seem to be artifacts of a particular method of investigation.

In spite of its many limitations the design permitted observation in a relatively controlled setting of developmental differences in cognitive behaviour which are often reported in less regulated circumstances. It allowed a description of this behaviour in a more clearly defined manner and it accurately limited the extent to which legitimate generalizations could be made from the observations.

The complex factorial analysis permitted both the control of a rather large number of variables, and, more important, the observation of the interacting impact of these variables.

The artificial quality of such an experiment cannot be ignored any more than can the peripheral nature of certain of the elements observed. The method employed, although suitable for the elucidation of some types of factors, necessarily obscures others which are of intense psychological interest. Awareness of the sorts of distortion involved in the selection of any specific method can only be acknowledged. As the Kendlers have said,

> "Much of the objection to S-R language stems from the apparent discrepancy between active, flowing behaviour and the inert, static, single S-R association. Using S-R language does not mean that complex behaviour actually consists of S-R connections. After analyzing the concept of light Toulmin...concludes: 'We do not find light atomized into individual rays: we represent it as consisting of such rays...' Applying the same idea to the concept of S-R association: 'We do not find behaviour atomized into individual S-R associations: we represent it as consisting of such S-R associations.' The concept of the S-R association, therefore, must be judged not in terms of its ability to provide a clear image of behaviour, but rather in its capacity to represent the facts of behaviour" (Kendler, Kendler & Learnard, 1962, p.3).

It is important to remember, however, that both the psychological model and the experimental method used leave their imprints on the sorts of results which are obtained, a point that the Kendlers (1966) make in taking issue with some

of the recent attacks of Mackintosh. His arguments for Sutherland's stimulus analyzers and his related criticisms of mediation seem to involve the exchange of one inadequate model for another in a more generalized fashion than the situation actually warrants.

Recent evidence concerning the psychology of the experimental situation suggests that there are many possible sources of distortion. First, the problem of experimenter bias cannot be ignored. The thorough studies of such researchers as I.G. Sarason (e.g., Ganzer & Sarason, 1964) make this abundantly clear. This is not to say that all possible safeguards were not taken in this study to insure control of this source of "contamination". Experimental procedures were standardized as completely as possible. Information about a subject's experimental group membership was kept separate from score sheets; communication between the subject and the experimenter was minimized during the task; and the scoring of the task itself was objective. But we know enough about the variability involved in psychological experiments to believe that a "naive" experimenter could perhaps have obtained different results. A further complication involves what Fillenbaum (1966) terms the problem of the faithful subject. He confirmed what others have reported: that subjects often respond in a manner, and with a degree of docility in an experimental

situation which would be quite alien to them under normal circumstances. These sources of bias relate to the situational structuring which has already been mentioned in reference to Eysenck's analysis of certain theoretical controversies.

With these qualifications in mind the discussion of the results of the present study can be seen in fair perspective.

The effects of age

This project was conceived at least partly as a developmental study in that at all times consideration of the performance of the children in the experimental group was qualified by knowledge of the performance of children at that and other developmental levels. Although chronological age was not manipulated as a multistaged variable, the one age group observed was specifically selected because of its expected characteristic performance on discrimination reversal and nonreversal shifts. Spiker, in a recent article on the concept of development (1966), points out the utility of such a procedure for examining ontogenetic characteristics. The fact that in the present study the group as a whole performed both types of shift

equally well confirms the Kendlers' findings with children of the same age. This contributes new evidence in that English children were observed on this task for the first time. These children, unlike subhuman organisms and preschool children, did not perform the nonreversal shift more readily, nor did they, like older human subjects, perform the reversal shift more easily. It is possible to say that some of the children were exhibiting the Piagetian ability to perform empirical reversals, but reversal facility was by no means universally displayed. For the purpose of analyzing the experimental variables the assumption was made, on the basis of previous developmental inferences, that the children in the present sample were in a transitional stage in their cognitive development.

It would be helpful to know just what skills are most closely associated with this transition in the mode of intellectual functioning. Reversal shift facility seems to involve not simply the possession of certain conceptual tools. It seems also to necessitate the active functioning of these tools. Investigators have reported that labels facilitate performance of simple discrimination learning in young children; they have also found that in more complex situations, and particularly with quite young subjects, labels do not aid performance before the children are old enough to integrate them into their working equipment. That

there are several steps in the preschoolers' development between the acquisition of a name for a concept and the effective participation of that concept in his intellectual functioning becomes increasingly clear. These issues will be discussed in more detail later.

The findings concerning the impact of rewards on performance have developmental implications primarily because the relative effectiveness of the different rewards did not confirm Zigler & Kanzer's developmental hypothesis. Not only was there no interaction between social group and incentive effects, but also the interaction between reward and intelligence which did occur was not in the predicted direction. In an earlier study (Cameron, 1964) when children worked for light flashes middle class children performed better than working class children, but when Smarties were the incentives, there was no difference in discrimination performance between social groups. This same type of effect was predicted here. Working class children were expected to work better to obtain Smarties or trinkets. This did not happen: the Zigler & Kanzer hypothesis was not confirmed. It was in fact only high IQ children whose performance was accelerated by the material rewards. These interactions will be discussed in more detail below. At this point it might be relevant to comment that the negative results could

have been a function of any of a number of factors. Perhaps the rewards made the situation unmanageable for those young children. The relatively complex discrimination task may have further confused the issue since the material-nonmaterial dichotomy has previously been employed with more simple tasks. We could also consider the negative findings to indicate the inadequacy of Zigler & Kanzer's theory. The negative findings of both McGrade and Rosenhan & Greenwald would also lead us to question the theory, but more research with a greater variety of reward dichotomies in different situations is needed. In an examination of the learning performance of six year olds a material-nonmaterial incentive dichotomy of the sort which has been employed may simply not be very meaningful.

The developmental aspect of the immediate vs. delayed reward technique is of considerable interest. Results from the pilot study pointed to an increased preference in English middle class children for delay with increasing age. In the main study, few children of six in any experimental group chose to delay gratification, but those who did were predominantly middle class children. From Mischel's data we might predict that as these children get older, more and more middle class children will prefer to delay in order to get a larger reward. Working class children are not so inclined to alter their choice with increasing age and so

the social group difference gets larger as the children get older. The "bird in the hand" approach appears to be common with most young children, but with age it becomes increasingly characteristic of working class children. Middle class children somehow learn to risk the delay in the expectation of a larger eventual reward.

Intelligence

Intellectual functioning, as measured by Raven's Progressive Matrices test, did not relate significantly to the performance of the training task, but it did relate to the successful performance of both shifts in interaction with sex (I x S) and incentive (I x R). The fact that there was not an expected interaction between intelligence and the type of shift required is perhaps a result of the limited nature of the test used. It seems that modes of cognitive functioning did not differ distinctly between IQ groups as they are differentiated by the Raven test on six year olds. Certainly there was throughout the sample a general superiority of most high IQ subgroups but this superiority was not entirely consistent. The IQ classification did not distinguish between the reversers and the nonreversers. It is interesting to speculate that bright children who performed the reversal shift well used

certain cues, perhaps of a verbal nature, while those high IQ children who performed the nonreversal shift so well had at their disposal other equally effective cognitive equipment, perhaps of a perceptual nature, to deal with that problem. The less bright children might have been deficient in a variety of cognitive tools and it might be this lack of scope which limited them on both shifts as well as on the Raven test. The situation is probably enormously more complex than has often been assumed.

Raven said (1951) that his test was one of perceptual reasoning and that it "indicates whether or not a person is, or is not, capable of forming comparisons and reasoning by analogy; and if not, to what extent, relative to other people, he is capable of organizing spatial perceptions into systematically related wholes" (p.3). He emphasized that such issues as the possession of certain acquired skills, could in no way be tested by his Matrices test. Although it proved an efficient measure for the present purpose, we might question its validity as a global indication of general intellectual functioning of the sort regarded by Osler and Rajalakshmi & Jeeves as relating to reversal behaviour in children.

The emergence in the covariance analysis of the two significant second order interactions, I x S x Sh and I x R x Sh, indicate that care must be taken if

generalizations are to be made concerning any of these variables. If we remove the effect of verbal fluency from the results of the discrimination task we find that statements about the effects of intelligence on performance must be qualified by consideration of both sex and motivational differences as well as the specific type of task involved. One safe generalization that we can make is this: if a task is rather complex, consideration of intelligence involves control of a subject's sex and his motivation. In general, however, we can also say that there was a greater variability in the performance of brighter children and quite a consistent superiority in the girls' performance. To disregard some indication of intellectual functioning in discrimination learning is evidently an error, but simply to control for it does not entirely solve the problem if, as these results indicate, intelligence interacts with so many other variables.

The very small relation between intelligence score and choice of delay in reward is interesting. Mischel has reported that brighter children in older samples more frequently choose a delayed reward. Perhaps brighter children have a better history of good experiences with adult promises, or maybe they learn earlier a time sense which would make the wait seem shorter than it does for less

bright children. Perhaps brighter children learn earlier to calculate a good risk.

Sex differences

Consideration of sex differences is also somewhat complicated. The interaction between sex and intelligence has already been mentioned. This differential sex effect tempts one to ask whether less bright boys may be the ones who suffer most from sex stereotyping behaviour on the part of adults. It is possible that a girl, regardless of her intellectual capacities is encouraged to take a duster in hand as she follows her mother about the house. This sharing of activities can lead both to heightened feelings of competence on the girl's part and a greater inclination on the mother's part to chat with the child. As a result, she may pick up some problem solving skills which she would not acquire on her own. A more studious boy might also draw adults into reciprocal activities, but the less bright or intellectually inclined boy might be the child who is most often encouraged to take his noises and fidgeting elsewhere. Such an interaction between sexual role and intelligence is the sort of effect which might be responsible for some of the conflicting reports concerning sex differences in congitive performance. In general, however, girls displayed

quite a marked superiority in performance to boys under most experimental conditions.

It was found, too, that sex interacted with social group membership. Again, girls on the whole excelled, but middle class girls were significantly superior in learning performance. Girls in the middle classes might again be the ones who more commonly obtain the kind of environmental stimulation that McCarthy has described as contributing to advances in female verbal facility. They are certainly the ones who have the most appropriate models in both mother and teacher. Any closeness between middle class girls and their mothers should foster behaviour on the part of the girls which would make them agreeable pupils for middle class women teachers. It is possible, then, that the interaction between sex and social group membership as well as the one between sex and intelligence could contribute to confusion concerning sex differences in cognitive processes.

Another possibility exists however; the girls may have done well in this task partly because the experimenter was a woman. Stevenson & Allen (1964) and Kennedy & Vega (1965) along with many others have recently provided evidence to suggest that the impact of certain characteristics of E, such as sex, social group membership, or race can have a profound effect on a subject's performance. It might be

expected that working class children and boys of either social group might not seek the approval of a middle class woman experimenter to the same extent as might girls, especially middle class girls.

When the covariance analysis was applied, the effect of sex differences was accentuated. Sex differences were effectively standardized out of the WISC Vocabulary which was the "X variable" in the analysis of covariance. The removal of the effect of verbal fluency reduced the variability on task performance within experimental groups. By compensating for the verbal deficiencies of the working class children and the facility of middle class children, as well as reducing the variability within sex groups, the covariance analysis revealed the girls to be distinctly more capable than the boys.

The fact that sex did not interact with reward effectiveness in task performance is provocative. Since few studies investigating reward effects have investigated sex differences, we do not know whether this negative result reflects the fact that sex differences in motivation do not emerge until a later age, or are absent from this type of task, or do not exist in the specific rewards used here. The fact that each child was allowed a choice between two material or nonmaterial rewards might have reduced this sort of variation. Brackhill and Jack did not control for

a sex effect in that they tested only male subjects. The lack of sex differentiation in relation to incentives is interesting in that so much emphasis is placed in the child rearing literature on the different motivational contexts, even in the preschool years, in which boys and girls are trained. There were also no sex differences in reward delay choices, a finding which Mischel has reported with his older subjects as well.

Environment

In spite of, or perhaps because of, the crudity of the method of classification of environment, the effects of this variable were great. The findings in the original variance analysis of the discrimination shift data were revealed even more emphatically in the analysis of covariance: when the social groups were equalized for verbal fluency, there remained distinct differences in the modes of cognitive functioning displayed. The effect of social group membership was clear in the performance of the children on the vocabulary, middle class children being significantly more fluent than working class children. Middle class children performed the reversal shift much better than they did the nonreversal shift. They seem to have at their disposal whatever skills are necessary for the successful performance of this more sophisticated form of discrimination shift.

Working class children performed the nonreversal shift as well as the middle class children did the reversal shift and they found the reversal shift as difficult as the middle class children did the nonreversal shift. The general level of performance over both shifts was similar for the two social groups.

Successful reversal shifting may involve a type of thinking which results from relatively active forms of discrimination. Nonreversal shifting, on the other hand, may involve more stimulus-bound styles of discrimination - that is, a less active approach to a problem. If this were the case, then perhaps environmental differences both in the home and at school would contribute to the social group variations in shifting performance found in this study.

Home differences such as the Newsons have found in such matters as the ways parents deal with their children's questions and their attitudes toward their children's play activities may relate to the differential shifting abilities. Middle class mothers' patterns of control seem to rely very heavily on verbal manipulation, reasoning, and arbitration; the Newsons have emphasized "...the premium which middle class parents put upon explicit verbal communication with their children..."(Newson & Newson, 1966, p. 67). In a forthcoming article concerning their study of four year olds

and their mothers, the Newsons[1] will say:

> "In part, the difference in quality of control lies in the preference which middle-class mothers show for the management of their children as far as possible through the use of reasoning. Explanations will be given for anything which the mother wishes the child to do, especially if he demurs, and she will also attempt to make him understand exactly why his own freedom has to be curtailed in any way. Tantrums and displays of jealousy and rage are treated in the same manner, as the middle-class mother tries to reach the child with a determinedly calm voice of reason, and makes a deliberate effort not to be infected by his own emotionality. Anyone who has experience of nursery-age children will know that appeals to the four-year old's reason are often rather poorly rewarded, especially in situations where emotions are already aroused; but it is characteristic of middle class mothers - and, in particular, of professional-class mothers - to treat their children from a very early age as if they are capable of being persuaded by rational argument, even when the initial success rate of this strategy is clearly very low. Working-class mothers, on the other hand, are less likely to embark upon any course which will involve them in lengthy verbal explanation of the whys and wherefores of what the child is supposed to be doing."

It is a very difficult thing, as any mother of several preschoolers knows, to respond warmly and encouragingly to a four year old who rushes into a hot kitchen shouting, "Mommie! cold's to what like hot's to warm?" Either conditions must be right or a mother must realize the

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1. Personal communication.

importance of searching for an answer despite the burning potatoes. Much research evidence would suggest that many working class children do not receive in the normal course of events the amounts of intellectual stimulation at home which might facilitate the development at an early age of more active, less stimulus-bound modes of conceptual activity.

School differences in the extent to which children were expected to share an understanding of what was going on appeared to exist in those observed in this study. The modes of control of the teachers in South Acton and Tower Hill (necessitated perhaps in their turn by relative lack of cooperative discipline at home) tended to be more rigid in their insistence on unreasoning obedience. Again, limitations of space and facilities in these schools could well hamper the kinds of exploratory ventures which facilitate the advancement of cognitive growth. Kellmer Pringle & McKenzie (1965) have reported in a study of teaching methods and rigidity in problem solving that less able children seem to suffer most in a traditional setting so far as problem solving ability is concerned. The children in the working class schools in this study may not have had the kinds of experiences at home or at school which would foster the development of the conceptual skills necessary for the ready performance of reversal shifts in discrimination.

In performing the reversal shift well, a child who finds himself no longer rewarded for responding to the stimulus he has learned, e.g. black, may possibly think on such lines as these: "Oh! black isn't right anymore. I must try something else." Such concepts as 'difference', 'other', 'opposition', or even 'negation', whether or not they are verbalized, are at least sufficiently detached from their original sensory moorings to be available for some general use. Moreover, the child demonstrates his belief both in the solubility of the problem and in his power to handle it.

If we can assume a developmental trend, the middle class children in this study can be seen to have been more advanced in the acquisition and <u>active</u> use of guiding concepts, whether or not they could be verbalized, which would allow them to think: "Black was right before, perhaps it is the other one now," where 'other' can be determined in more than one way.

In contrast, it is tempting to suppose that the working class children may have been still at the stage of development when a more limited range of conceptual skills was actively available to them. The awareness of difference in perceptual coordinates i.e., of size and colour, adequate for a nonreversal shift, was there but the grasp, however obscure and unverbalized, of the opposition implied in a reversal shift was not yet readily available.

It would be informative to observe the shifting performance of a group of working class children ranging in age from about four to ten to see if the pattern of increased reversal facility progresses in the same orderly fashion with age as it does with middle class children. It would also be interesting to know if adults in the general population, particularly working class adults tend to reverse as readily as college student subjects.

A recent monograph (Lesser, Fifer & Clark, 1965) demonstrated that different patterns as well as levels of cognitive abilities can be observed with different social groups. We have assumed that the abilities which facilitate reversal shifting are most readily stimulated in a middle class milieu. There, the child is believed to have the greatest opportunity for the profitable sharing of experience with adults.

This sharing must occur with caretakers (c.f. Reeves, 1965, Chapter 11) who patiently help the child to adapt to and take copy from his environment, if it is to be advantageous to the child. The evidence from the present experiment would suggest that certain social experiences will serve to advance the child's cognitive development better than others, and that it is middle class children who at six have benefitted from the kinds of socialization that make them capable of more sophisticated discrimination

shifts than working class children are able to perform. It would be interesting to know if the children who reversed more readily would display relatively less egocentric speech while problem solving than would children who performed the nonreversal shift best.

That the environments of the two social groups observed here were distinctly different deserves emphasis once again. The experiences of the East London child have been portrayed many times over. Such literary treatment as Arthur Morrison's The Hole in the Wall or A Child of the Jago are surprisingly apposite in the 1960's in Tower Hill. Williamson's recent account (1963) verifies this. Similarly, the situation in South Acton differed greatly from that of either middle class school; the educational environment being made even more problematic by the recently increasing problem of overcrowding complicated by a new large immigrant population (Hawkes, 1966). The experience of middle class children has been less frequently captured in novels or explored in depth by sociologists, but the Newson study of the English middle class four year olds gives some indication of the adult involvement in the psychological and intellectual welfare of these children. The middle class schools in this sample quite obviously reflected the same sorts of involvements as the Newsons have noted. Had the

children in this study been more evenly distributed along a social or economic scale, the impact of social group membership would probably not have been so obvious.

Unfortunately we do not know in any detail what constellations of factors were tapped in the social group classification. Swift's very interesting study (1967) examines the effects of six different aspects which are often involved in the social variable: economic position, family size, parental occupation, family occupational mobility, parental education, and parental attitudes toward education. He showed the relation between each of these elements and eleven plus success. It would be important to know what factors in the different environments observed here were related to the differences in shifting ability displayed. Since we are not in command of enough valid information concerning the social variable, we can only speculate at this point. Social group in this instance then could perhaps best be described as involving a multiplicity of effects which combined to relate strongly to discrimination learning. From the present evidence it would seem unwise to underestimate the importance of environment to such specific forms of cognitive performance as reversal learning.

Vocabulary

Results from the administration of the WISC Vocabulary Subtest proved informative. The variance analysis of vocabulary scores revealed differences between social groups (middle class children excelled) and a significant interaction between sex and intelligence as measured by the Raven test (high IQ boys excelled on the WISC Vocabulary). Not surprisingly, children who scored poorly on the Raven obtained low scores on the WISC, and boys' scores varied more than girls' did. The fact that middle class children performed the vocabulary so much better than working class children confirms the many previous findings concerning social differences in linguistic abilities.

The large variance ratios in the covariance analysis can partly be attributed to the very small error term which resulted from the extraction of vocabulary variations. It seems that by equating the experimental group in terms of their verbal fluency, a relatively rigorous control of the experimental variables was obtained. There was a strong relationship within the experimental groups between WISC performance and general performance on both of the discrimination shift tasks. The removal of the variability of scores related to vocabulary inequalities did not alter the general picture of the effects or their interactions as

they were revealed in the original analysis.

It might have been expected that the impact of the social group variable might have been decreased when fluency was controlled. Verbal fluency as measured by the WISC would not be expected to be highly related to the active functioning of verbal mediators since the understanding of verbal labels does not necessarily imply their active participation in problem solving. That shifting differences remained between social groups after the covariance analysis was computed indicated that it would be fruitful to look for the kinds of skills involved in shifting behaviour in other directions as well as the verbal. It would of course be interesting to record subjects' verbalizations on a variety of concepts during problem solving. It was beyond the scope of the present study to do this, but if the children had been encouraged to talk as they worked, useful information might have emerged.

Reward condition

The effect of reward condition on the performance of the training task and of the shifts was, as has been described, negligible. The group as a whole performed equally well for either reward. The reward choices within the task of the various experimental groups (Smarties vs. trinkets and light vs. bell) are recorded in Table 30. Trinkets were chosen

more often than Smarties (41 to 23), but the light and bell were about equally popular (34 to 30). There were no significant differences (using chi-square tests) between experimental groups on their reward choices, e.g. although girls seemed to prefer trinkets, boys chose trinkets and Smarties almost equally often so there was no significant sex effect. Further, there was no relation between level of task performance on any particular reward choice for the group as a whole; for example, children who chose trinkets to work for performed no better than those who chose Smarties.

The interaction between intelligence and reward was not in a direction which would be predicted from previous studies, so speculation must be undertaken with care. It is possible that the trinkets and Smarties proved distracting to the performance of the less bright children and that their usual motivational appeal could therefore only be observed in the brighter childrens' performance at this age. Although the material rewards seemed to appeal to the children, it was subjectively clear during the experiment that children who received the material rewards worked slightly more slowly than nonmaterial subjects. There was often quite a long pause between the time when the reward was dispensed and when the next response was made. It is unfortunate that the trials were not timed. Perhaps the less bright children

at this age could not attend to the material rewards without for a moment forgetting the task. This attentional split, which was not so apparent under nonmaterial reward conditions, may have decreased only the performance of the lower IQ children. The nonmaterial rewards may have been neither so rewarding nor so confusing.

Since the school setting more commonly involves acknowledgement of correctness by abstract rewards and seldom by sweets, perhaps some children were made uneasy by the thought of obtaining concrete rewards at school. Or possibly they interpreted the nonmaterial rewards as being more likely to be endorsed by the experimenter, an adult rather similar to their teachers. Such symbolic interpretations may be broad extrapolations from the data. What does seem plain is that the material-nonmaterial dichotomy may not be at all meaningful when applied to very young school children in a fairly complex problem situation.

Whether or not the technique of reward choices within the task - the material choice between Smarties and trinkets and the nonmaterial choice between the light flash and the bell tinkle - served to reduce the variability within the experimental groups cannot be known without a control group. There was no plan to test this. It was accepted from Brackbill & Jack's description of it, that it would be a

distinct practical aid. They said,

> "The results of the present study are relevant to some common methodological problems. First, an experimenter who employs a simple analysis of variance design, using children as Ss frequently finds that between-group differences are large, but that size of the within-groups variability is even more impressive. The present findings suggest that the use of individually determined reinforcers will reduce such error variance" (Brackbill & Jack, 1958, p.189).

The variability within groups was very small here as well and it is tempting to believe that the attempt to control reward value in this way produced the desired effect. The low mean scores of all experimental groups were some indication that adequate motivation was captured.

Results from the incentive variable on the task conflict to some extent with those obtained from the Mischel delay of gratification technique since the delay preference has in other studies been related to the ability to work for nonmaterial rewards. The questions evoked by the application of the incentive variable to the task seem to overshadow any leads that it might have provided. Ultimately, the value of incentives in the discrimination learning is quite unknown for children at the age of six.

Delay of reward

A problem posed by the delay of reward technique is that it assumes that a large chocolate bar is in fact preferable in an absolute sense, to a smaller one. This

may perhaps be a rash assumption, for instance, if a subject does not care for chocolate. The child could also have seen the situation as a test of his politeness and willingness to accept that which was more readily available. It has been observed previously with older middle class children (Cameron, 1964) that some felt that to choose the larger delayed reward would reveal poor manners. But this type of politeness training, which is apparently strongly emphasized in middle class homes (Newson & Newson, 1966) presumably competes with training which involves the ability to delay gratification for larger eventual rewards. Our empirical evidence suggests that the power to delay dominates in middle class children during the school years. The relationship between family background and delay preference in English middle class children adds an interesting bit of information for cultural comparisons. The predominant tendency for the six year olds in this sample as a whole was to choose the immediate but smaller reward. This tendency is reminiscent of the residents of the east end of London described in A Child of the Jago when condemned property was offered for cheap rental:

> "Still the rents were reduced: that was the immediate consideration, and nothing but an immediate consideration carried weight in the Jago, where a shilling today was to be preferred to a constant income beginning in a month's time. The effect of the announcement was a rush of applications for rooms in the doomed houses..." (Morrison,1946, p.102).

Mischel described this same quality in his youngest subjects as well as in his older working class ones. The developmental interpretation of the fact that middle class children were beginning to prefer to delay gratification is derived from Mischel's theory.

The present study is one of the few in which a female experimenter presented the choice. It would be interesting to know if a male experimenter would obtain similar results. Since trust and personal expectations have been shown to relate to ability to delay, it would also be interesting to know whether there would be an increase in delay choices with an English experimenter. In most previous studies, the reward choices were given by experimenters who were complete strangers to the children, as well as being foreigners. In the present study the experimenter was a familiar visitor to the school by the time the choice was given. It was also given immediately after the child had received a bag of Smarties or trinkets. There were fairly good grounds for the child to believe that he would receive the reward if he wanted to wait for it.

We have little directly relevant information on psychological time which might help us in our analysis. But considering the total situation, the technique was probably a fairly reliable index of a child's desire to

wait a while in order to obtain a larger return. And it seems very likely that this sort of choice is taught primarily to children in middle class homes.

The task

This study was not designed to investigate the perceptual processes involved in the performance of the experimental task. Such "irrelevant" aspects of the stimuli as position of the correct response were ignored. It is known that very young subjects and many subhuman organisms respond in terms of position. Consequently the position of the correct stimuli were simply randomized, with all runs longer than three omitted. The Gellermen sequences (1933) would have been preferable, but it would have been even more desirable to have been able to account for all dimensions of a stimulus. It is in this area that Sutherland's experimental designs would be instructive. A subject in the present study could have been working out solutions in terms of position, the size or shape of the grey background, a combination of the size and brightness aspects of the stimulus dimensions, in a mixture of strategies, or in some sort of trial and error manner dependent on reinforcement strengths.

Since the Kendlers had reported that their size-brightness dimensions were of equal difficulty for six year

olds, these were used interchangeably in this experiment. This procedure would not necessarily be safe with different age groups, or with other types of stimuli. The varying difficulty of different concepts cannot be ignored, especially with young human subjects. Lee (1965) reported developmental differences in the utilization of concepts of size, colour, number, and form between three and six year olds. Corah (1966), comparing colour and form discrimination in nursery (four years plus) and school aged (seven to nine years) children, found that younger children gave more colour responses than older children, although they were not classified as "colour dominant". Stevenson & McBee (1958) have reported that the rate of learning in young children is a function both of the type and relative size of the stimuli. When comparing the differences in the discrimination learning of four to six year olds they found that objects, which they call <u>stereometric</u> stimuli were more easily discriminated than patterns, <u>planometric</u> ones. The objects were assumed to offer tactual and kinesthetic cues which especially aided the discrimination of their young subjects. The Kuenne study used stereometric stimuli, the Kendler studies and the present one, planometric. This aspect of the stimulus is particularly important in the early years when perceptual cues may dominate more than they do later on.

It can be recalled that Raven recognized this difference when he designed the form board version of his test.

One further aspect of the stimulus situation which was touched upon earlier in relation to Isaacs & Duncan's study is the influence of numbers of extra dimensions on discrimination learning. Recently, Dickerson (in press) and Bryant (1967) as well as Johnson (1966) have explored the more complex situation where a number of irrelevant dimensions are manipulated in order to observe their impact on a central problem. Johnson has shown that reversal and interdimensional shifts are made more difficult by numbers of additional dimensions, but such intradimensional shifts as do not involve reversals are unaffected. In an article with Bailey (1966) Johnson demonstrated that all of the characteristics of the stimulus are vital to interpretation of the experimental results:

> "The results of this study are essentially a validation of the contention that in discrimination behaviour the relational or absolute nature of responses can be manipulated by selection of stimulus properties, number of implicit response rules, and S characteristics. It is clear from the data...that any puristic theory of discrimination learning is incomplete" (Johnson & Bailey, 1966, p. 37a).

A careful examination of all aspects of a stimulus is quite obviously needed. There are many aspects of the stimuli even in the present rather simple task which remain in the final analysis virtually unexplored here. So any

generalizations made from the present data ought to be qualified at this point by reference to such matters as the specific nature of the task, and the type of stimuli used.

Conclusion

Finally, several statements can be made quite firmly on the basis of the present findings. For instance it can be most misleading to make developmental observations on the basis of the discrimination behaviour of groups of subjects who are highly selected either in terms of their intellectual ability, or their environmental background. The effects of scored intelligence on shift performance is complicated by interactions with sex, incentives, and the type of shift involved. Subjects who scored well on Raven's Matrices test did not maintain their original superiority in general shift performance once the effects of verbal fluency as measured by the WISC Vocabulary were removed. The impact of such a global indication of environmental stimulation as type of school attended on discrimination shifts was great, even after the effects of vocabulary had been equalized. Working class six year olds were found to perform the nonreversal shift best, indicating that perhaps they were at a less advanced stage in their cognitive development than middle class children of the same age.

Middle class children were found to perform the reversal shift best, thus exhibiting behaviour similar to that of older human subjects, behaviour thought to involve more complex conceptual skills, such as verbal mediators, or more sophisticated organizational principles. It is safe to say that generally speaking, environment is related to specific cognitive abilities, but the specific sorts of stimulation that are involved in the acquisition, say, of reversing skill, is not known. The reward condition yielded negative results. Social group was seen to relate to sex in a way that revealed a possible source of ambiguity in previous results on sex differences in cognitive processes. Only middle class girls performed much better than boys of either social group or working class children of either sex.

These findings with six year old English children performing a learning task and discrimination shift both verified several developmental hypotheses and provided downward extensions on the chronological data on a number of variables. This kind of empirical exploration, even when one recognizes its limitations, represents a useful approach to the investigation of certain areas of the motivational and cognitive worlds of the young child. The careful accumulation of this sort of information should ultimately

contribute both to the broadly based construction of theories of behaviour as well as to pools of information from which guidance in more practical psychological spheres can be obtained. Alterations in infant education such as the Plowden report suggests and such campaigns as the Headstart Project in the United States depend upon information of this sort: information which is derived under quite well controlled and therefore well defined conditions. There is a practical educational need to understand both the general structure of the child's capacities under certain conditions, and also the extent of his flexibility. As Bruner, on the basis of the accumulating psychological evidence has said,

> "...the intellectual development of the child is no clockwork sequence of events; it also responds to influence from the environment. Thus instruction on scientific ideas need not follow slavishly the natural course of cognitive development of the child. It can also lead development by providing challenging but usable opportunities for the child to forge ahead in his development" (Bruner, 1961, p.39).

Both enrichment programmes and theories depend on accurate information concerning the abilities of the child and the sources of stimulation of such skills. With careful experimental investigation we should increasingly be able to define with greater clarity the early sources of cognitive flexibility and thus be capable of making reliable generalizations about ways in which such experiences as those of early deprivation might be minimized. This study takes

us only a very small way in this direction but the results indicate that the very considerable possibilities of investigations of this kind.

Summary

This study was designed to examine the effects of various factors on a young child's ability to execute discrimination shifts in an experimental learning situation. A factorial design was planned so that both the effects of the variables and their interactions could be tested. The five dichotomous variables controlled were: scored IQ, sex, social group membership, type of shift required, and kind of reward presented. Chronological age was controlled in that a specific age indicated in the research literature to be critical in the development of shifting ability was selected. Verbal facility, as measured by a vocabulary test was used to check the effect of fluency on the performance of discrimination shifts.

Children were classified as high or normal IQ test scorers on the basis of their performance on the childrens' version of Raven's Progressive Matrices (1947) test. Males and females were grouped separately. Social group was decided on the basis of the type of school attended. Children attending fee paying schools in middle class residential districts in London were called middle class; children in state schools in working class residential and commercial sections in London were designated working class. The training task involved each subject's learning to respond

to one aspect of one dimension of the stimuli presented. Stimuli varied in size and brightness. If a subject was initially trained to respond to black, a reversal or intradimensional shift would involve his responding to white; a nonreversal or extradimensional shift would require responses to large or small. Half of the subjects in each experimental group were trained to perform the reversal and the other half, the nonreversal type of shift. Rewards of one of two types were given for each correct response: either a material reward (a sweet or a trinket) or a nonmaterial reward (a light flash or a bell ring). Within either reward condition a subject could choose which reward he wished to work for. Finally, subjects chose between taking a small immediate or a larger delayed reward.

A sample of 128 children were distributed evenly between the 32 cells of the factorial design, four to a cell. All children were between five and a half and six and a half years of age at the time of testing with a mean age of five years ten months. This age was chosen because research has shown that children between five and seven years, approximately, perform reversal and nonreversal shifts in discrimination equally well. Since they have been described as being in a transitional stage in their cognitive development at this chronological age, it was predicted that the impact of the chosen variables might be highlighted in any

differential shift performance observed under the various experimental conditions. The effect of verbal fluency on shifting ability was controlled statistically by an analysis of covariance. Each child was tested on the WISC Vocabulary Subtest and his score on this was analyzed in relation to his score on the discrimination shift.

The results can be summarized in the following way. Scores on the training task revealed minimal effects from the controlled variables. Only the effects of social group membership proved to influence the speed of learning of the initial discrimination. In general the children in the middle class groups learned the task more readily than did working class children. Scores on this and the subsequent task represented the number of trials taken before the criterion of nine correct out of ten consecutive responses was reached. The scores were transformed before variance analyses were computed.

On the discrimination shift, the following effects were observed. First, the children as a whole performed each type of shift with relative ease, as was predicted. But type of shift interacted with social group membership. Middle class children reversed more easily than working class children, who performed the nonreversal shift slightly more easily. Intelligence interacted with type of incentive

with high IQ children performing better for material rewards. Girls performed both types of shift better than boys, with middle class girls excelling most.

A high degree of relationship was observed between WISC Vocabulary scores and shift performance within the cells of the experimental groups. The analysis of covariance between these two measures produced several second-order interactions and very high F ratios which required some explanation. This analysis revealed a picture essentially the same as before with the impact of social group and sex accentuated after the effects of verbal fluency were equalized. Two higher order interactions showed intelligence interacting with both reward and sex, and both of these effects interacting with shift type. It seems reasonable to suggest then that nothing can be safely said of the effect of any of these factors without reference to one or more of the other variables.

The choice of either a delayed or an immediate reward provided further evidence concerning this technique. With this group there was a mild relationship between social group and reward. More middle class children chose the delayed reward. The vast majority of working class children chose the immediate smaller reward.

We can say, finally, that children of five and a half to six and a half performed reversal and nonreversal shifts

with equal ease. Middle class children, however, reversed more readily than they performed the nonreversal shift. Sex differences appeared to be important; girls performed in general, better than boys. The interaction between sex and social group showed that the middle class girls were the most advanced in this type of problem-solving situation. Intelligence score as reflected on Raven's Progressive Matrices test discriminated between general levels of task performance but not between the abilities involved in executing the different shifts. Children in high IQ groups performed better for material than for nonmaterial rewards. We can conclude that none of these variables can safely be ignored in the investigation of the development of intellectual functioning as it is reflected in discrimination learning tasks of this sort.

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Appendix A: Tables

1. Findings of previous studies Tables 1 - 3

2. The present analyses Tables 4 - 30

Table 1

Means and standard deviations of six experimental groups on last ten trials

Group	$\bar{X}$	SD
White-collar, material	6.55	2.35
White-collar, nonmaterial	7.82	1.64
Blue-collar, material	6.27	1.21
Blue-collar, nonmaterial	5.00	2.41
Indian, material	6.55	1.36
Indian, nonmaterial	5.36	0.88

Table 2

Analysis of variance for last ten trials

Source of variation	SS	df	MS	F
Group	29.302	2	14.651	4.337 *
Condition	2.561	1	2.561	0.758
Interaction: group x condition	22.937	2	11.467	3.395 *
Within groups	202.660	60	3.378	
Totals	257.460	65		

* significant at .05 level

Table 3

Data from Pilot Study

(N=45)

Age	IQ	Sex	Reward	Shift	Ss	Train # of trials	Shift # of trials	Reward choice
				R	1	27	26	DelR
			M	⌣ R	2	2	9	DelR
		Ma			3	16	0	ImR
			⌣	⌣	4	6	9	ImR
			M	R	5	13	12	ImR
					6	37	2	ImR
	High		M	⌣ R	7	2	3	ImR
					8	29	23	DelR
		Fe	⌣ M	R	9	5	1	ImR
					10	12	14	ImR
Under $6\frac{1}{2}$ years				⌣ R	11	1	7	ImR
					12	6	13	ImR
				R	13	32	49	ImR
			M		14	23	3	ImR
					15	32	4	DelR
		Ma		⌣ R	16	5	14	ImR
	Normal				17	49	11	ImR
					18	35	17	DelR
			⌣ M	R	19	20	5	ImR
					20	16	6	ImR
				⌣ R	21	5	7	ImR
			M	R	22	53	7	ImR
		Fe	⌣ M	R	23	2	13	ImR
				R	24	2	0	DelR
					25	5	1	DelR
			M	⌣ R	26	5	13	DelR
					27	5	6	ImR
		Ma			28	5	3	DelR
	High			R	29	5	4	ImR
			⌣ M		30	5	13	DelR
				⌣ R	31	0	2	DelR
					32	12	2	ImR
			M	R	33	5	1	ImR
Over $6\frac{1}{2}$ years		Fe	⌣ M	R	34	3	1	DelR
					35	4	6	DelR
			M	R	36	28	2	DelR
		Ma		⌣ R	37	12	2	ImR
			⌣ M	R	38	5	11	DelR
					39	4	4	ImR
	Normal		M	R	40	7	1	DelR
				⌣ R	41	3	2	DelR
		Fe			42	1	1	ImR
			⌣ M	⌣ R	43	2	7	DelR
					44	6	6	ImR
					45	5	3	DelR

Table 4

Distribution of subjects

School population	Ss in final sample	Division by sex	
		Boys	Girls
Mill Hill	40	16	24
Fulham	24	16	8
South Acton	40	18	22
Tower Hill	24	14	10
Totals	128	64	64

Table 5

The design

Raven Score	Sex	Social Group	Reward	Shift
Normal	Male	Working	Material	Nonreversal
				Reversal
			Nonmaterial	Nonreversal
				Reversal
		Middle	Material	Nonreversal
				Reversal
			Nonmaterial	Nonreversal
				Reversal
	Female	Working	Material	Nonreversal
				Reversal
			Nonmaterial	Nonreversal
				Reversal
		Middle	Material	Nonreversal
				Reversal
			Nonmaterial	Nonreversal
				Reversal
High	Male	Working	Material	Nonreversal
				Reversal
			Nonmaterial	Nonreversal
				Reversal
		Middle	Material	Nonreversal
				Reversal
			Nonmaterial	Nonreversal
				Reversal
	Female	Working	Material	Nonreversal
				Reversal
			Nonmaterial	Nonreversal
				Reversal
		Middle	Material	Nonreversal
				Reversal
			Nonmaterial	Nonreversal
				Reversal

Table 6

Totals and means of transformed scores on discrimination learning task of experimental variables

Variables	Training task Totals	Training task Means	Discrimination shift Totals	Discrimination shift Means
Raven score	Σ_H = 158.356	$\bar{X}_H$ = 2.474	Σ_H = 143.196	$\bar{X}_H$ = 2.237
	Σ_N = 180.377	$\bar{X}_N$ = 2.818	Σ_N = 165.353	$\bar{X}_N$ = 2.584
Sex	Σ_M = 177.766	$\bar{X}_M$ = 2.778	Σ_M = 171.374	$\bar{X}_M$ = 2.678
	Σ_F = 160.967	$\bar{X}_F$ = 2.515	Σ_F = 137.175	$\bar{X}_F$ = 2.143
Social group	Σ_{MJ} = 149.372	$\bar{X}_{MJ}$ = 2.334	Σ_{MJ} = 135.411	$\bar{X}_{MJ}$ = 2.116
	Σ_{WK} = 189.361	$\bar{X}_{WK}$ = 2.959	Σ_{WK} = 173.138	$\bar{X}_{WK}$ = 2.705
Reward	Σ_M = 167.886	$\bar{X}_M$ = 2.623	Σ_M = 152.666	$\bar{X}_M$ = 2.385
	$\Sigma_{\tilde{M}}$ = 170.847	$\bar{X}_{\tilde{M}}$ = 2.670	$\Sigma_{\tilde{M}}$ = 155.883	$\bar{X}_{\tilde{M}}$ = 2.436
Shift	Σ_R = 159.448	$\bar{X}_R$ = 2.491	Σ_R = 154.619	$\bar{X}_R$ = 2.416
	$\Sigma_{\tilde{R}}$ = 179.285	$\bar{X}_{\tilde{R}}$ = 2.801	$\Sigma_{\tilde{R}}$ = 153.930	$\bar{X}_{\tilde{R}}$ = 2.405

Table 7

Analysis of variance for training task

Source	SS	df	MS	F
I (Raven score)	3.7885	1	3.7885	1.8460
S (sex)	2.2047	1	2.2047	1.0743
G (social group)	12.4931	1	12.4931	6.0874 *
R (reward condition)	.0685	1	.0685	<1
Sh (shift required)	3.0743	1	3.0743	1.4980
I x S	.1605	1	.1605	<1
I x G	.0230	1	.0230	<1
I x R	.0013	1	.0013	<1
I x Sh	.0304	1	.0304	<1
S x G	.0236	1	.0236	<1
S x R	1.8038	1	1.8038	<1
S x Sh	.6700	1	.6700	<1
G x R	2.8010	1	2.8010	1.3648
G x Sh	2.2746	1	2.2746	1.1083
R x Sh	1.5534	1	1.5534	<1
I x S x G	.3165	1	.3165	<1
I x S x R	3.7637	1	3.7637	1.8339
I x S x Sh	.3906	1	.3906	<1
I x G x R	.0140	1	.0140	<1
I x G x Sh	1.7552	1	1.7552	<1
I x R x Sh	2.2053	1	2.2053	1.0746
S x G x R	1.2346	1	1.2346	<1
S x G x Sh	1.6130	1	1.6130	<1
S x R x Sh	.8458	1	.8458	<1
G x R x Sh	2.3542	1	2.3542	1.1471
I x S x G x R	.0397	1	.0397	<1
I x S x G x Sh	.4815	1	.4815	<1
I x S x R x Sh	3.4726	1	3.4726	1.6921
I x G x R x Sh	8.1381	1	8.1381	3.9654 *
S x G x R x Sh	.9967	1	.9967	<1
I x S x G x R x Sh	.0158	1	.0158	<1
Error	197.0210	96	2.0523	
Total	255.6290	127		

* significant at .05 level

Table 8

Analysis of variance for discrimination shift

Source	SS	df	MS	F
I (Raven score)	3.8354	1	3.8354	4.8415 *
S (sex)	9.1373	1	9.1373	11.5341 ***
G (social group)	11.1197	1	11.1197	14.0365 ***
R (reward condition)	.0809	1	.0809	<1
Sh (shift required)	.0037	1	.0037	<1
I x S	8.3370	1	8.3370	10.5239 **
I x G	1.0744	1	1.0744	1.3562
I x R	10.2124	1	10.2124	12.8912 ***
I x Sh	.5564	1	.5564	<1
S x G	4.2512	1	4.2512	5.3663 *
S x R	.1605	1	.1605	<1
S x Sh	.0033	1	.0033	<1
G x R	13614	1	.3614	<1
G x Sh	13.7753	1	13.7753	17.3857 ***
R x Sh	.3933	1	.3933	<1
I x S x G	1.1603	1	1.1603	1.4647
I x S x R	.0235	1	.0235	<1
I x S x Sh	2.0435	1	2.0435	2.5795
I x G x R	.0099	1	.0099	<1
I x G x Sh	.1556	1	.1556	<1
I x R x Sh	1.9437	1	1.9437	2.4535
S x G x R	1.0084	1	1.0084	1.2729
S x G x Sh	.1951	1	.1951	<1
S x R x Sh	.7115	1	.7115	<1
G x R x Sh	.5425	1	.5425	<1
I x S x G x R	.1490	1	.1490	<1
I x S x G x Sh	.4464	1	.4464	<1
I x S x R x Sh	.0338	1	.0338	<1
I x G x R x Sh	.4224	1	.4224	<1
S x G x R x Sh	.0015	1	.0015	<1
I x S x G x R x Sh	.0107	1	.0107	<1
Error	76.0515	96	.7922	
Total	148.2115	127		

* significant at .05 level
** significant at .01 level
*** significant at .001 level

Table 9

Analysis of variance of discrimination shift (2^6 design)

Source	SS	df	MS	F
I (Raven score)	3.8354	1	3.8354	4.3733 *
S (sex)	9.1373	1	9.1373	10.4188 **
G (social group)	11.1197	1	11.1197	12.7674 **
R (reward condition)	.0809	1	.0809	<1
Sh (shift required)	.0037	1	.0037	<1
T (training speed)	.1020	1	.1021	<1
I x S	8.3370	1	8.3370	9.5063 **
I x G	1.0744	1	1.0744	1.2251
I x R	10.2124	1	10.2124	11.6447 **
I x Sh	.5564	1	.5564	<1
I x T	.0253	1	.0253	<1
S x G	4.2512	1	4.2512	4.8474 *
S x R	.1605	1	.1605	<1
S x Sh	.0033	1	.0033	<1
S x T	.0008	1	.0008	<1
G x R	.3614	1	.3614	<1
G x Sh	13.7753	1	13.7753	15.7073 **
G x T	.9297	1	.9297	1.0601
R x Sh	.3933	1	.3933	<1
R x T	.5414	1	.5414	<1
Sh x T	.0042	1	.0042	<1
I x S x G	1.1603	1	1.1603	1.3230
I x S x R	.0235	1	.0235	<1
I x S x Sh	2.0435	1	2.0435	2.3301
I x S x T	.1578	1	.1578	<1
I x G x R	.0099	1	.0099	<1
I x G x Sh	.1556	1	.1556	<1
I x G x T	.2276	1	.2276	<1
I x R x Sh	1.9437	1	1.9437	2.2163
I x R x T	.0063	1	.0063	<1
I x Sh x T	.3913	1	.3913	<1
S x G x R	1.0084	1	1.0084	1.1498
S x G x Sh	.1951	1	.1951	<1
S x G x T	.1654	1	.1654	<1
S x R x Sh	.7115	1	.7115	<1
S x R x T	.1658	1	.1658	<1
S x Sh x T	.0142	1	.0142	<1
G x R x Sh	.5435	1	.5435	<1
G x R x T	.7204	1	.7204	<1
G x Sh x T	.8072	1	.8072	<1
R x Sh x T	1.4393	1	1.4393	1.6412
I x S x G x R	.1490	1	.1490	<1
I x S x G x Sh	.4464	1	.4464	<1
I x S x G x T	.3004	1	.3004	<1
I x S x R x Sh	.0338	1	.0338	<1
I x S x R x T	.0165	1	.0165	<1
I x S x Sh x T	1.9050	1	1.9050	2.2643
I x G x R x Sh	.4224	1	.4224	<1
I x G x R x T	.3742	1	.3742	<1
I x G x Sh x T	.2371	1	.2371	<1
I x R x Sh x T	.7848	1	.7848	<1
S x G x R x Sh	.0015	1	.0015	<1
S x G x R x T	1.5996	1	1.5996	1.8239
S x G x Sh x T	1.4932	1	1.4932	1.7026
S x R x Sh x T	2.4666	1	2.4666	2.8057
G x R x Sh x T	.5852	1	.5852	<1
I x S x G x R x Sh	.0107	1	.0107	<1
I x S x G x R x T	.1041	1	.1041	<1
I x S x G x Sh x T	.4192	1	.4192	<1
I x S x R x Sh x T	.0257	1	.0257	<1
I x G x R x Sh x T	2.8528	1	2.8528	3.2529
S x G x R x Sh x T	.5081	1	.5081	<1
I x S x G x R x Sh x T	1.7138	1	1.7138	1.9542
Error	56.1296	64	.8770	
Total	148.2115	127		

* significant at .05 level
** significant at .01 level

Table 10

Transformed scores for each subject on training task and discrimination shift, and WISC vocabulary scaled scores

	Normal IQ												High IQ											
	Male						Female						Male						Female					
	Wk			Md			Wk			Md			Wk			Md			Wk			Md		
	Train	Shift	WISC	Train	Shift	WISC	Train	Shift	WISC	Train	Shift	WISC	Train	Shift	WISC	Train	Shift	WISC	Train	Shift	WISC	Train	Shift	WISC
Material A	2.550	2.915	6	5.701	2.121	13	1.581	2.550	4	3.082	.707	13	3.674	5.738	13	3.082	2.345	18	3.536	2.739	10	.707	1.225	15
	7.246	2.739	8	2.550	3.674	11	2.345	3.937	6	.707	1.225	8	2.345	2.550	10	.707	1.581	8	1.225	3.674	11	1.225	1.871	6
	1.581	4.848	9	2.121	1.871	12	4.183	4.183	9	4.416	.707	3	2.550	1.871	15	.707	1.581	12	2.345	1.581	7	1.225	1.871	17
	2.739	4.062	10	.707	2.345	11	2.550	3.937	8	2.345	1.581	7	2.345	.707	8	.707	1.871	11	5.738	2.915	9	3.937	.707	13
	2.121	2.121	4	1.225	4.416	15	1.225	3.240	4	1.225	1.871	9	1.225	1.225	11	1.581	3.082	17	2.345	2.345	15	2.121	.707	17
	3.082	3.240	1	2.550	3.391	13	3.674	1.581	13	2.345	2.121	10	1.581	1.581	5	2.121	2.121	13	2.345	1.581	8	2.550	.707	15
	4.416	5.956	11	1.581	4.743	7	5.642	1.581	13	1.225	1.581	13	.707	1.581	14	4.062	.707	16	3.808	2.121	13	2.345	2.550	9
	4.637	2.345	7	2.345	3.808	7	4.391	3.391	13	1.581	2.121	13	4.950	.707	10	4.848	2.121	11	4.062	1.871	10	1.581	1.871	12
	1.225	2.739	6	1.581	3.082	12	1.581	2.550	8	1.225	1.225	9	2.345	3.937	10	1.225	1.225	11	.707	2.915	12	1.581	1.871	13
	3.674	2.739	6	2.550	.707	12	4.637	3.082	14	2.550	.707	9	4.062	3.536	8	2.345	2.739	14	2.345	2.345	12	2.550	2.121	14
Nonmaterial A	1.225	4.416	10	2.345	3.240	14	3.937	3.240	7	1.225	1.225	9	3.536	4.062	11	3.391	2.345	19	2.345	2.121	10	1.225	1.225	10
	4.528	2.550	7	2.345	2.739	10	2.345	1.871	10	2.345	1.225	13	6.205	1.225	15	2.345	1.871	13	.707	2.915	6	.707	2.550	3
	2.550	3.674	4	4.062	2.550	11	3.082	2.121	12	1.225	2.550	14	.707	3.082	13	2.550	3.536	7	3.674	2.915	6	3.674	2.550	11
	2.550	1.581	6	.707	2.739	6	.707	1.871	18	3.240	1.581	14	4.743	2.739	12	3.536	1.581	18	2.550	3.240	9	2.345	3.674	9
	3.536	3.391	14	4.528	2.345	8	3.536	2.121	8	3.240	1.225	11	3.536	.707	12	2.550	3.082	16	2.550	3.391	14	3.808	2.915	7
	2.739	2.121	9	5.956	4.183	13	4.062	2.345	14	5.786	.707	11	3.536	2.550	13	.707	2.345	15	1.225	1.581	8	.707	2.550	11

Table 11

Totals and means of scaled scores on selected experimental variables: WISC Vocabulary Subtest

Variables	Totals	Means
Raven score	Σ_H = 741	$\bar{X}_H$ = 11.58
	Σ_N = 620	$\bar{X}_N$ = 9.69
Sex	Σ_M = 692	$\bar{X}_M$ = 10.81
	Σ_F = 669	$\bar{X}_F$ = 10.45
Social Group	Σ_{Md} = 742	$\bar{X}_{Md}$ = 11.59
	Σ_{WK} = 619	$\bar{X}_{WK}$ = 9.67

Table 12

Analysis of variance for WISC Vocabulary (2^3 design)

Source	SS	df	MS	F
I (Raven score)	114.3828	1	114.3828	10.7945 **
S (Sex)	4.1328	1	4.1328	<1
G (Social group)	118.1953	1	118.1953	11.1543 **
I x S	64.6953	1	64.6953	6.1054 *
I x G	.0078	1	.0078	<1
S x G	37.1953	1	37.1953	3.5102
I x S x G	9.5703	1	9.5703	<1
Error	1271.5626	120	10.5964	
Total	1619.7422	127		

* significant at .05 level
** significant at .01 level

Table 13

Analysis of variance for WISC vocabulary

Source	SS	df	MS	F
I (Raven score)	114.3828	1	114.3828	10.8178 **
S (sex)	4.1328	1	4.1328	<1
G (social group)	118.1953	1	118.1953	11.1783 **
R (reward condition)	3.4453	1	3.4453	<1
Sh (shift required)	15.8203	1	15.8203	1.4962
I x S	64.6953	1	64.6953	6.1186 *
I x G	.0078	1	.0078	<1
I x R	23.6328	1	23.6328	2.2351
I x Sh	2.8203	1	2.8203	<1
S x G	37.1953	1	37.1953	3.5178
S x R	1.7578	1	1.7578	<1
S x Sh	41.6328	1	41.6328	3.9374
G x R	10.6953	1	10.6953	1.0015
G x Sh	1.3203	1	1.3203	<1
R x Sh	.9453	1	.9453	<1
I x S x G	9.5703	1	9.5703	<1
I x S x R	48.7578	1	48.7578	4.6113 *
I x S x Sh	43.9453	1	43.9453	4.1561 *
I x G x R	.1953	1	.1953	<1
I x G x Sh	1.7578	1	1.7578	<1
I x R x Sh	14.4453	1	14.4453	1.3662
S x G x R	2.2578	1	2.2578	<1
S x G x Sh	.6328	1	.6328	<1
S x R x Sh	9.5703	1	9.5703	<1
G x R x Sh	8.5078	1	8.5078	<1
I x S x G x R	3.4453	1	3.4453	<1
I x S x G x Sh	2.2578	1	2.2578	<1
I x S x R x Sh	.0703	1	.0703	<1
I x G x R x Sh	.3828	1	.3828	<1
S x G x R x Sh	17.2578	1	17.2578	1.6322
I x S x G x R x Sh	.9453	1	.9453	<1
Error	1015.0629	96	10.5736	
Total	1619.7422	127		

* significant at .05 level
** significant at .01 level

Table 14

Analysis of covariance for discrimination shift and WISC vocabulary

Source	(Adjusted) SS	df	MS	F	
I (Raven score)	16.4369	1	16.4369	58.2869	***
S (sex)	11.6479	1	11.6479	41.3046	***
G (social group)	29.1353	1	29.1353	103.3167	***
R (reward condition)	.1211	1	.1211	<1	
Sh (shift required)	.5107	1	.5107	1.8110	
I x S	20.1055	1	20.1055	71.2961	
I x G	.7553	1	.7553	2.6784	
I x R	17.4628	1	17.4628	61.9248	***
I x Sh	.8848	1	.8848	3.1376	
S x G	10.8592	1	10.8592	38.5078	***
S x R	.1205	1	.1205	<1	
S x Sh	1.7551	1	1.7551	6.2238	*
G x R	1.3753	1	1.3753	4.8770	*
G x Sh	15.3453	1	15.3453	54.4160	***
R x Sh	.3485	1	.3485	1.2358	
I x S x G	2.7128	1	2.7128	9.6199	**
I x S x R	2.3887	1	2.3887	8.4706	**
I x S x Sh	7.6747	1	7.6747	27.2152	***
I x G x R	-.3211	1	<1	<1	
I x G x Sh	.1120	1	.1120	<1	
I x R x Sh	4.5630	1	4.5630	16.1809	***
S x G x R	1.4221	1	1.4221	5.0429	*
S x G x Sh	.0212	1	.0212	1	
S x R x Sh	1.9515	1	1.9515	6.9202	**
G x R x Sh	1.5326	1	1.5326	5.4348	*
I x S x G x R	.2721	1	.2721	<1	
I x S x G x Sh	.6385	1	.6385	2.2642	
I x S x R x Sh	-3012	1	<1	<1	
I x G x R x Sh	.2587	1	.2587	<1	
S x G x R x Sh	.5402	1	.5402	1.9156	
I x S x G x R x Sh	-.2587	1	<1	<1	
Error	26.7869	95	.2820		

* significant at .05 level
** significant at .01 level
*** significant at .001 level

Table 15

Comparisons of the significant effects in the discrimination shift analysis of variance with the analysis of covariance between that shift and the WISC Vocabulary (Tables 8 and 14)

Source	Significance levels (P) of: Variance analysis	Covariance analysis
I	*	***
S	**	***
G	***	***
I x S	**	***
I x R	***	***
S x G	*	***
S x Sh		(*)
G x R		(*)
G x Sh	***	***
I x S x G		(**)
I x S x R		(**)
I x S x Sh		***
I x R x Sh		***
S x G x R		(*)
S x R x Sh		(**)
G x R x Sh		(*)

Note. — Bracketed significance levels of interactions not used.

* significant at .05 level
** significant at .01 level
*** significant at .001 level

Adjustment of means from analysis of covariance

X = WISC Vocabulary Subtest

Y = Discrimination shift scores

Y' = Adjusted shift scores

$\bar{Y}' = \bar{Y} - b(\bar{X} - \bar{\bar{X}})$ where $b = \frac{Exy}{Exx} = -.2211$

Table 16

G x R x Sh interaction

	Wk				Md			
	Mat		Mat		Mat		Mat	
	R	R	R	R	R	R	R	R
$\bar{X}$	8.938	9.500	9.500	10.750	11.125	12.313	11.563	11.375
$\bar{Y}$	3.187	2.279	2.890	2.464	1.705	2.370	1.881	2.507
$\bar{Y}'$	2.812	2.028	2.639	2.490	1.814	2.741	2.087	2.671

Table 17

S x R x Sh interaction

	Male				Female			
	Mat		Mat		Mat		Mat	
	R	R	R	R	R	R	R	R
$\bar{X}$	10.938	10.125	11.125	11.063	9.125	11.688	9.938	11.063
$\bar{Y}$	2.679	2.697	2.697	2.638	2.213	1.953	2.074	2.334
$\bar{Y}'$	2.746	2.585	2.806	2.733	1.880	2.186	1.920	2.429

Table 18

S x G x R interaction

	Male				Female			
	Wk		Md		Wk		Md	
	M	M	M	M	M	M	M	M
$\bar{X}$	8.875	9.750	12.188	12.438	9.563	10.500	11.250	10.500
$\bar{Y}$	2.765	2.816	2.611	2.519	2.702	2.539	1.464	1.869
$\bar{Y}'$	2.376	2.621	2.955	2.918	2.465	2.510	1.600	1.840

Adjusted means from analysis of covariance (cont.)

Table 19

I x R x Sh interaction

	Normal				High			
	Mat		$\widetilde{Mat}$		Mat		$\widetilde{Mat}$	
	R	$\widetilde{R}$	R	$\widetilde{R}$	R	$\widetilde{R}$	R	$\widetilde{R}$
$\bar{X}$	8.625	9.563	9.750	10.813	11.438	12.250	11.313	11.313
$\bar{Y}$	2.713	2.969	2.334	2.319	2.180	1.680	2.438	2.652
$\bar{Y}'$	2.269	2.732	2.139	2.359	2.358	2.038	2.588	2.802

Table 20

I x S x Sh interaction

	Normal				High			
	Male		Female		Male		Female	
	R	$\widetilde{R}$	R	$\widetilde{R}$	R	$\widetilde{R}$	R	$\widetilde{R}$
$\bar{X}$	9.813	8.500	8.563	11.875	12.250	12.688	10.500	10.875
$\bar{Y}$	2.924	3.288	2.122	2.001	2.452	2.047	2.165	2.286
$\bar{Y}'$	2.743	2.816	1.664	2.276	2.810	2.501	2.136	2.340

Table 21

G x Sh interaction

	Wk		Md	
	R	$\widetilde{R}$	R	$\widetilde{R}$
$\bar{X}$	9.219	10.125	11.344	11.844
$\bar{Y}$	3.039	2.372	1.793	2.438
$\bar{Y}'$	2.726	2.260	1.950	2.706

Table 22

S x G interaction

	Wk		Md	
	Ma	Fe	Ma	Fe
$\bar{X}$	9.313	10.031	12.313	10.875
$\bar{Y}$	2.790	2.620	2.565	1.666
$\bar{Y}'$	2.493	2.487	2.736	1.719

Table 23

Reward choices of main sample (N=128)

Reward choice	Normal IQ Male Wk	Normal IQ Male Md	Normal IQ Female Wk	Normal IQ Female Md	High IQ Male Wk	High IQ Male Md	High IQ Female Wk	High IQ Female Md
ImR	13	11	14	12	14	10	12	12
DelR	3	5	2	4	2	6	4	4

Table 24

Reward choices of Ss not included in main sample but who performed all tests (N=80)

Reward choice	Normal IQ Male Wk	Normal IQ Male Md	Normal IQ Female Wk	Normal IQ Female Md	High IQ Male Wk	High IQ Male Md	High IQ Female Wk	High IQ Female Md
ImR	11	5	12	8	2	10	3	7
DelR	1	1	5	1	1	8	3	2

Table 25

Reward choices of Ss rejected by chance (N=61)

Reward choice	Normal IQ Male Wk	Normal IQ Male Md	Normal IQ Female Wk	Normal IQ Female Md	High IQ Male Wk	High IQ Male Md	High IQ Female Wk	High IQ Female Md
ImR	10	5	11	6	1	4	2	2
DelR	0	1	5	1	1	8	2	2

Table 26

Reward choices of combined groups: main sample (N=128) + chance rejects (N=11). Total N=139

Reward choice	Normal IQ				High IQ			
	Male		Female		Male		Female	
	Wk	Md	Wk	Md	Wk	Md	Wk	Md
ImR	23	16	25	18	15	14	14	14
DelR	3	6	7	5	3	14	6	6

Table 27

Reward choices of second form working class children (N=30)

Reward choice	Male		Female	
	under 7	over 7	under 7	over 7
ImR	4	6	8	1
DelR	2	4	1	4

Table 28

Reward choices of first and third form middle class children (N=23)

Reward choice	Male		Female	
	4-5 yrs.	over 7	4-5 yrs.	over 7
ImR	3	4	9	3
DelR	2	0	0	2

Table 29

Reward choices of third form (age 9) and fifth form (age 11) middle class children (N=16)

Reward choice	Normal IQ				High IQ			
	Male		Female		Male		Female	
	$9_{yrs.}$	$11_{yrs.}$	$9_{yrs.}$	$11_{yrs.}$	$9_{yrs.}$	$11_{yrs.}$	$9_{yrs.}$	$11_{yrs.}$
ImR	1	1	0	1	1	0	1	0
DelR	0	1	2	2	2	3	0	1

Table 30

Reward choices of Ss on discrimination learning task (N=128)

Reward choice	Normal IQ				High IQ			
	Male		Female		Male		Female	
	Wk	Md	Wk	Md	Wk	Md	Wk	Md
Trinkets	5	4	5	7	4	4	6	6
Smarties	3	4	3	1	4	4	2	2
Lights	3	6	2	5	5	6	2	5
Bells	5	2	6	3	3	2	6	3

Appendix B: Figures

1. Figures from previous research Figures 1 - 2

2. The present results Figures 3 - 21

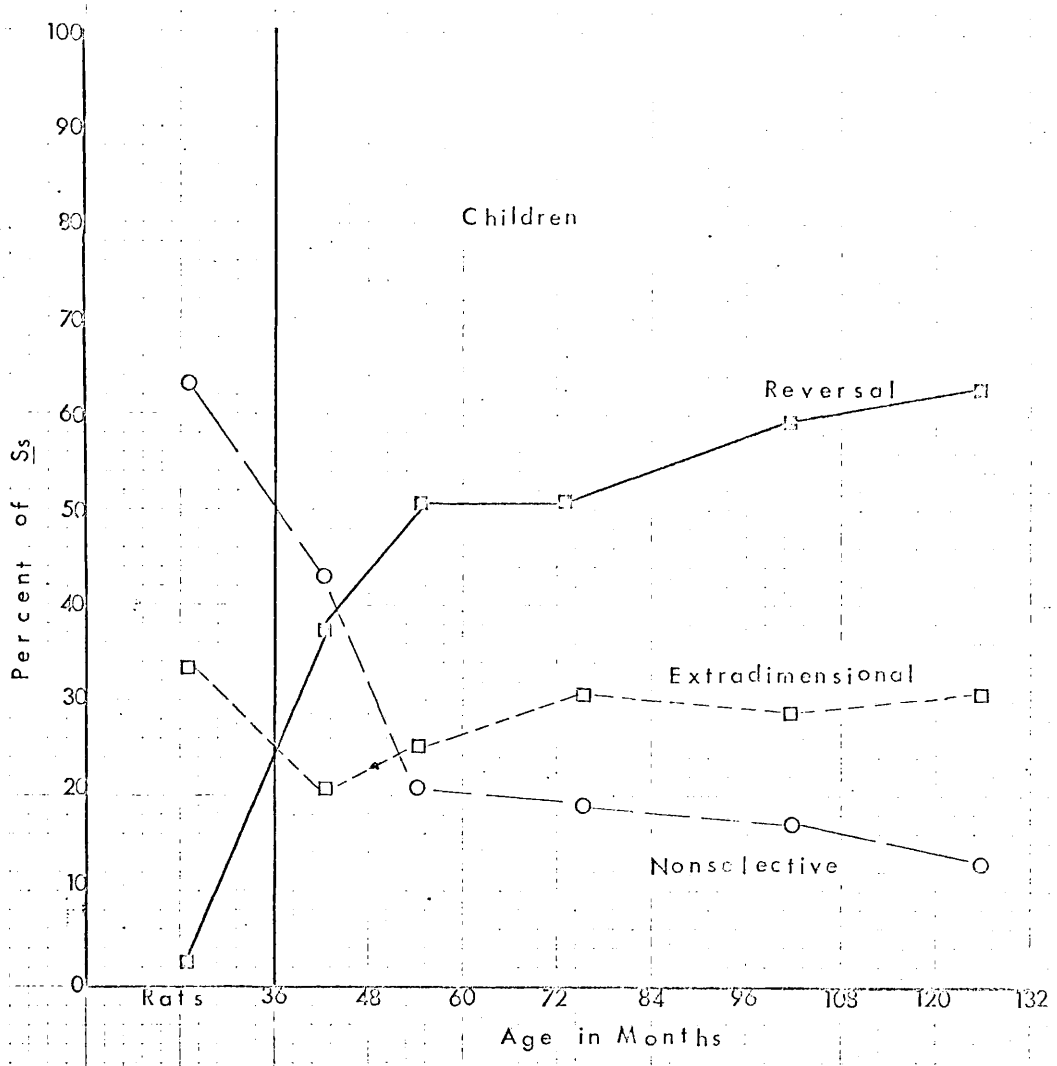

Figure 1. The percentage of Ss responding in each optional shift category for rats and children of different ages (from Kendler, Kendler & Silfen, 1964, p. 6).

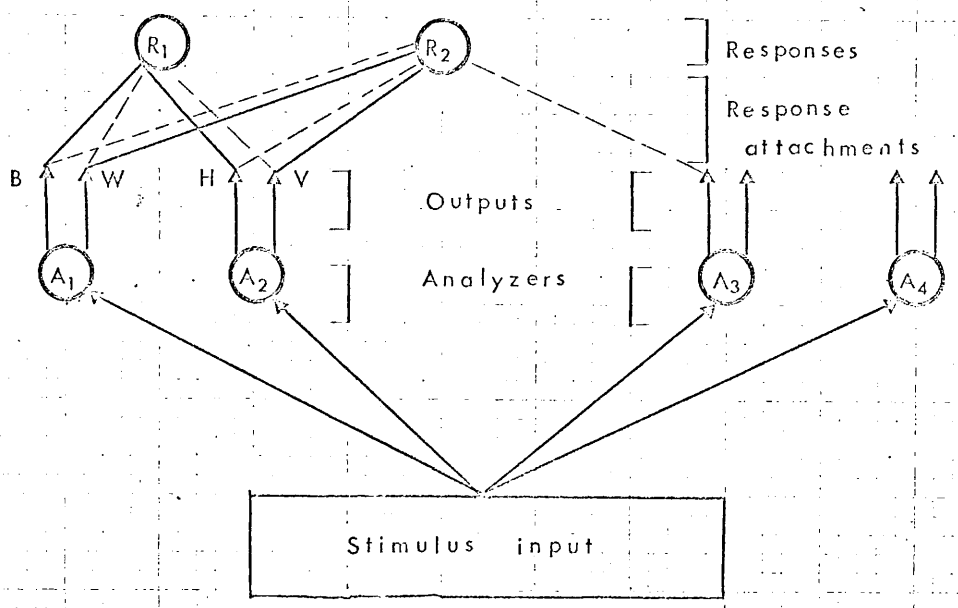

Figure 2. Diagram of Sutherland's model (from Sutherland, 1964a, p. 149).

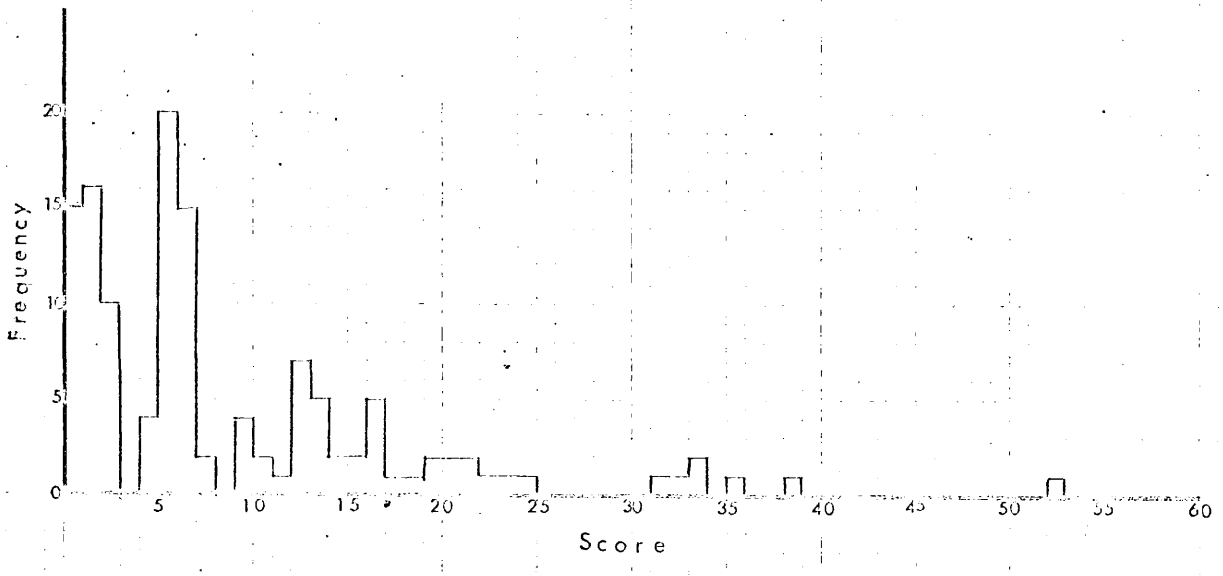

Figure 3. Number of trials to criterion on training task (N= 128).

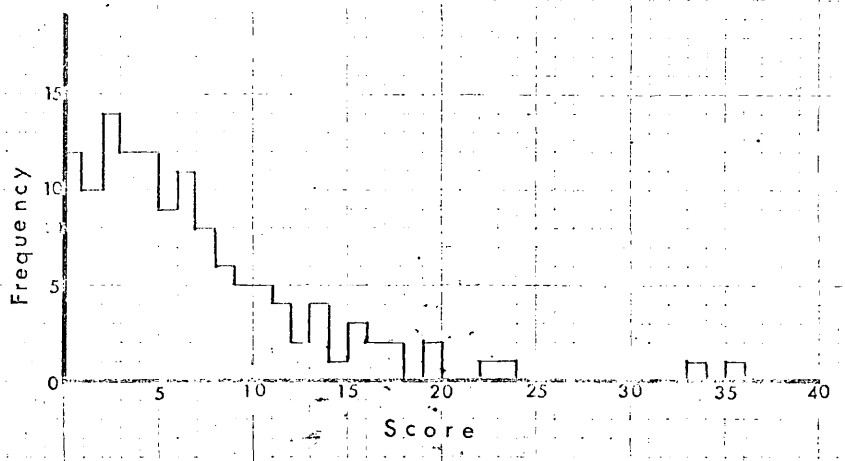

Figure 4. Number of trials to criterion on discrimination shift, all shifts taken together (N= 128).

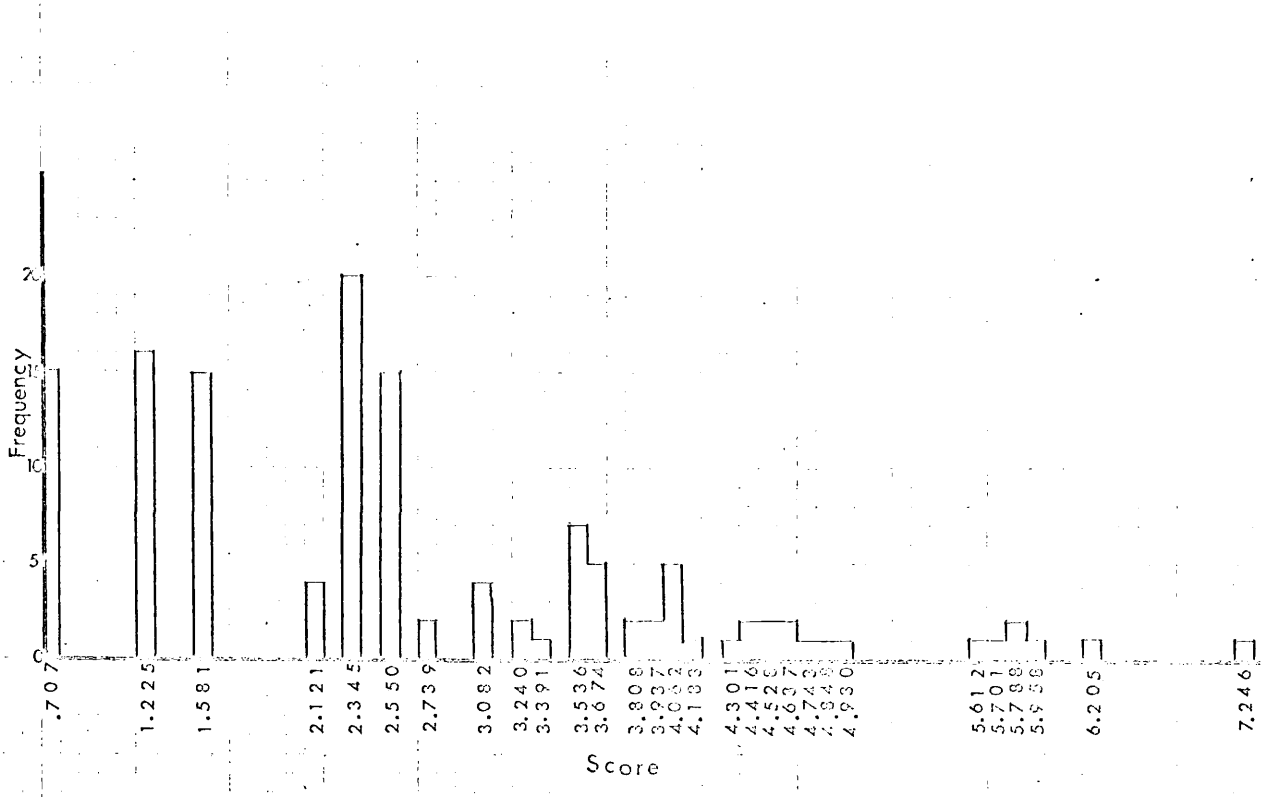

Figure 5. Transformed scores of trials to criterion on training task (N= 128).

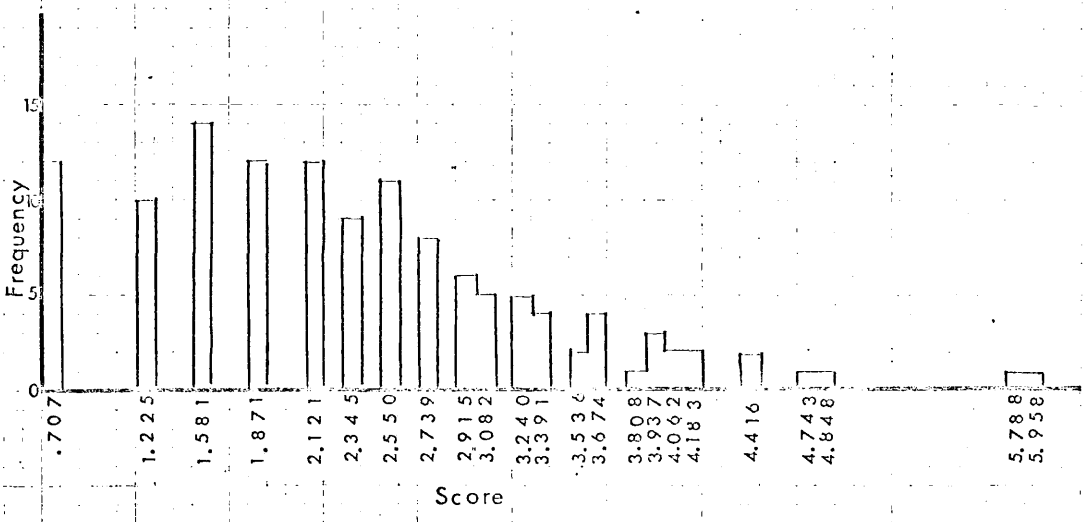

Figure 6. Transformed scores of trials to criterion on discrimination shift (N= 128).

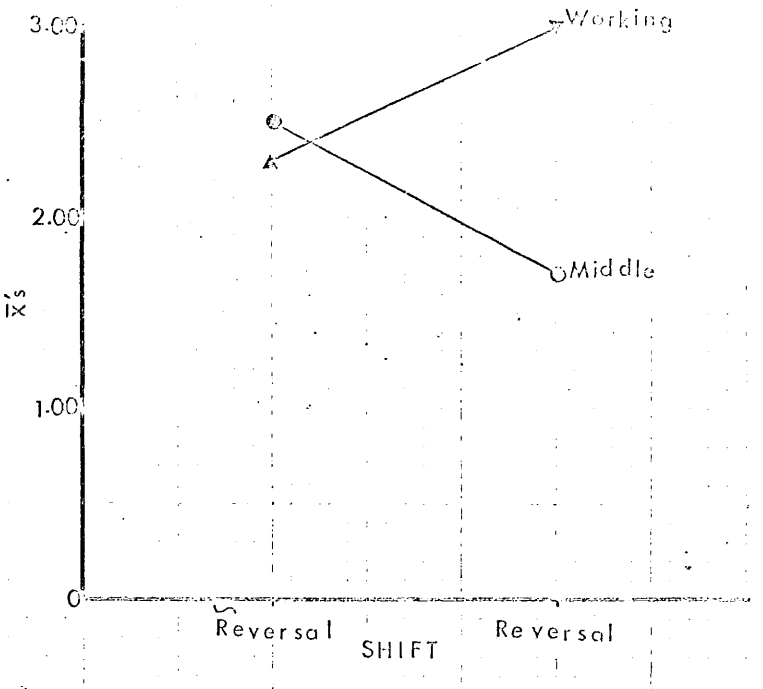

Figure 7. Interaction G x Sh (social group by shift) in discrimination shift from analysis of variance.

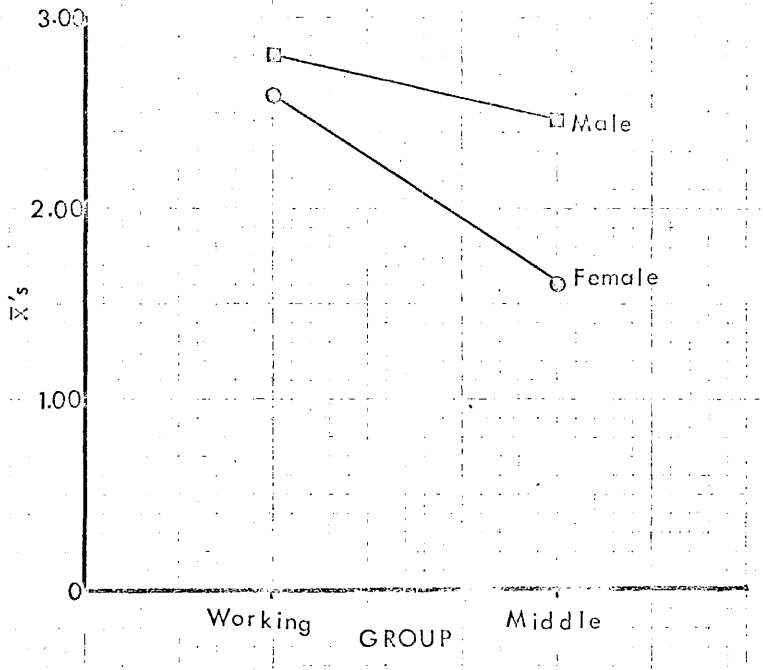

Figure 8. Interaction S x G (sex by social group) in discrimination shift from analysis of variance.

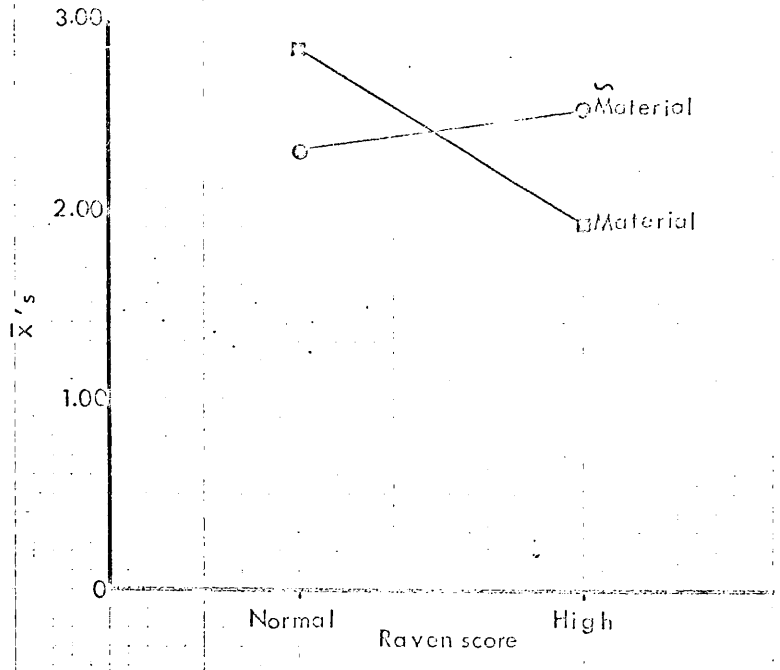

Figure 9. Interaction I x R (Raven score by reward) in discrimination shift from analysis of variance.

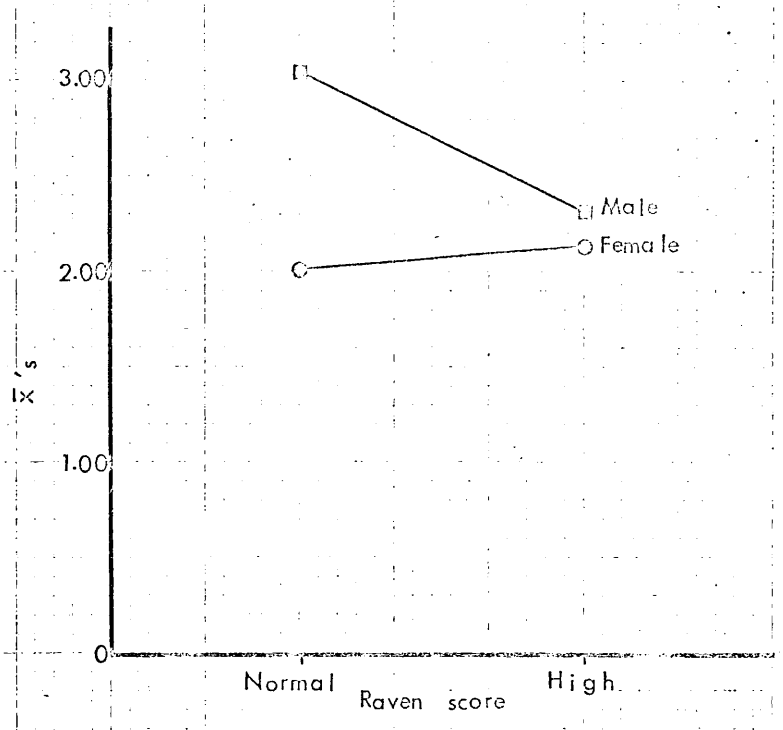

Figure 10. Interaction I x S (Raven score by sex) in discrimination shift from analysis of variance.

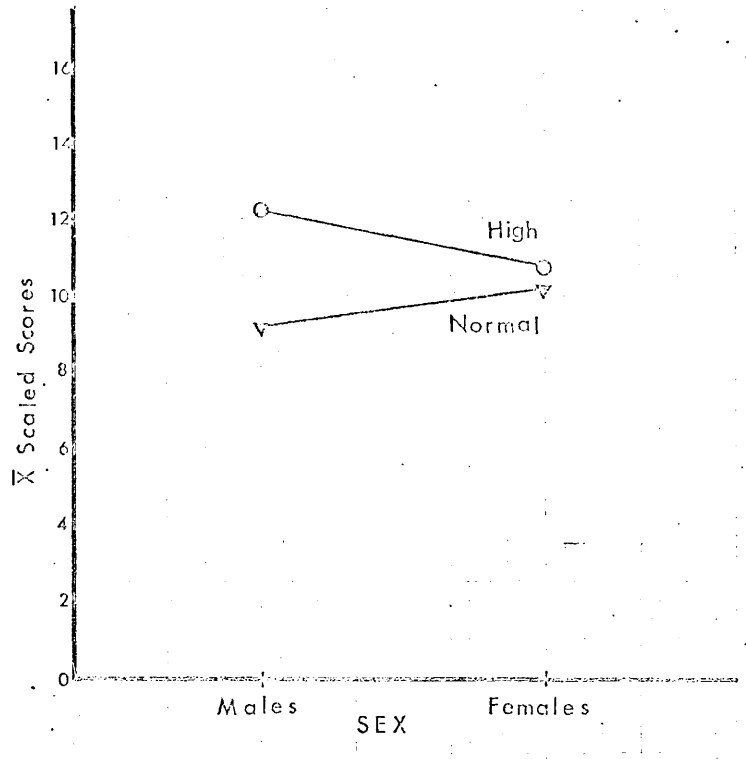

Figure 11. Significant interaction from analysis of variance of WISC vocabulary: I x S (Raven score by sex).

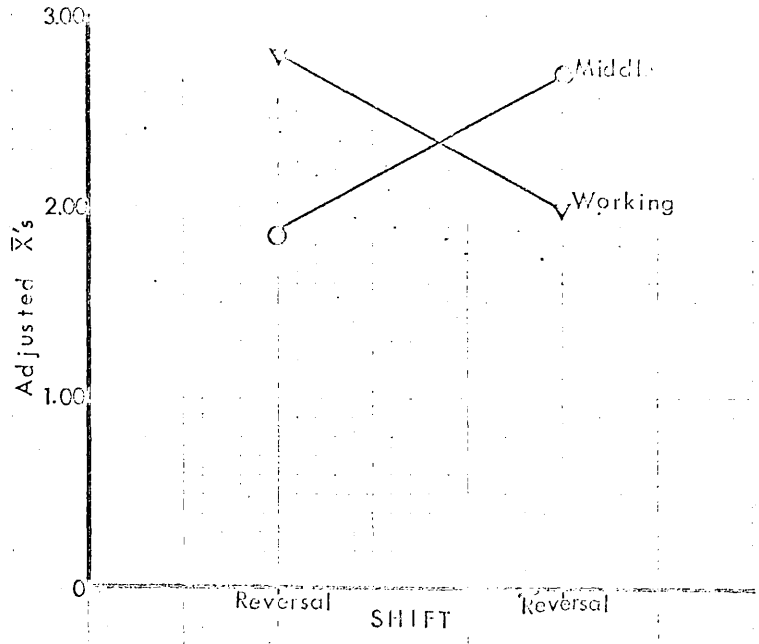

Figure 12. Adjusted G x R x Sh interaction for analysis of covariance: G x Sh aspect under material rewards.

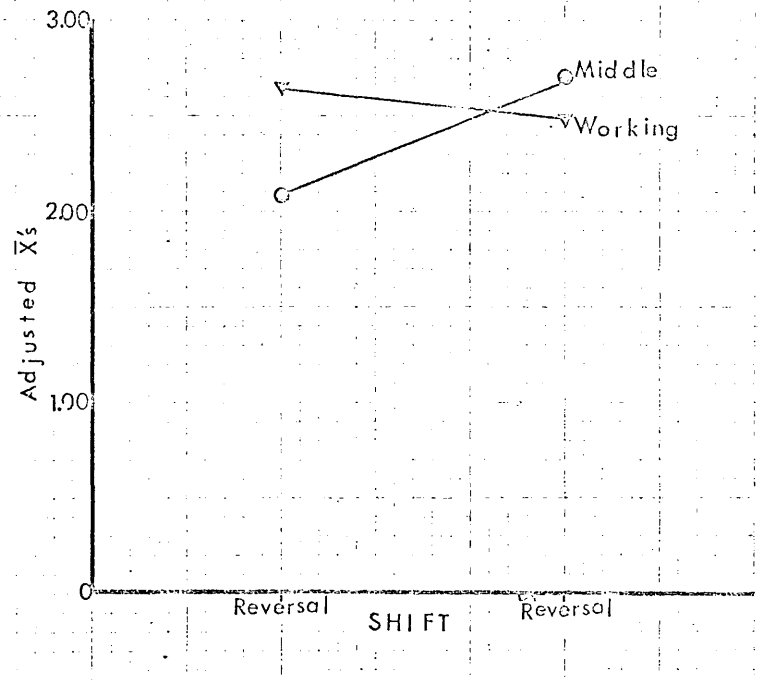

Figure 13. Adjusted G x R x Sh interaction for analysis of covariance: G x Sh aspect under nonmaterial rewards.

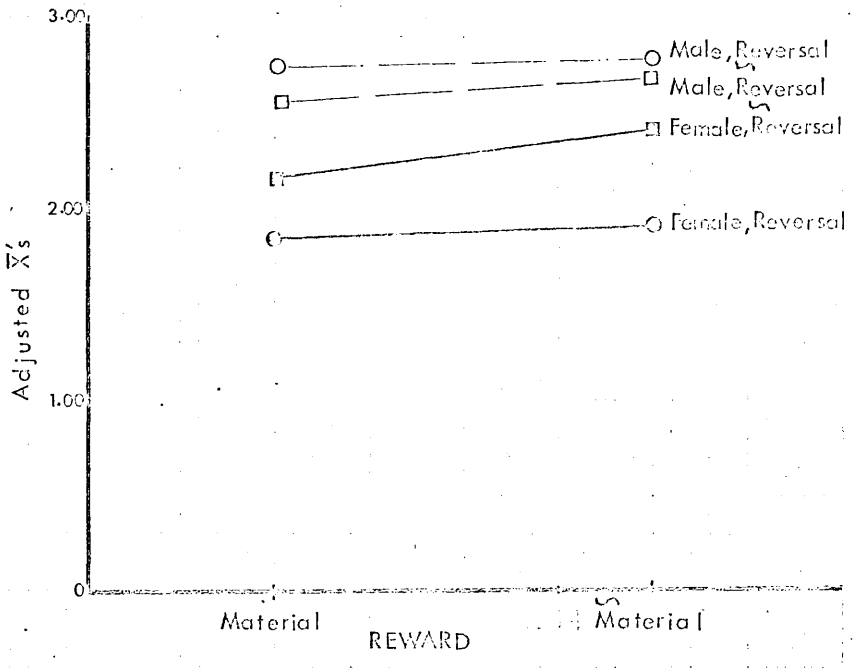

Figure 14. Adjusted S x R x Sh interaction for analysis of covariance: R x Sh aspect for both sexes.

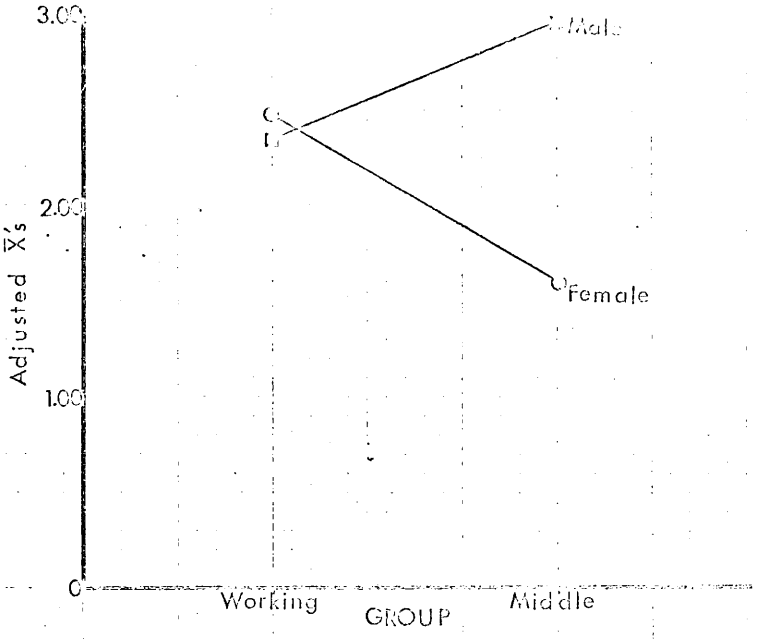

Figure 15. Adjusted S x G x R interaction for analysis of covariance: S x G aspect under material rewards.

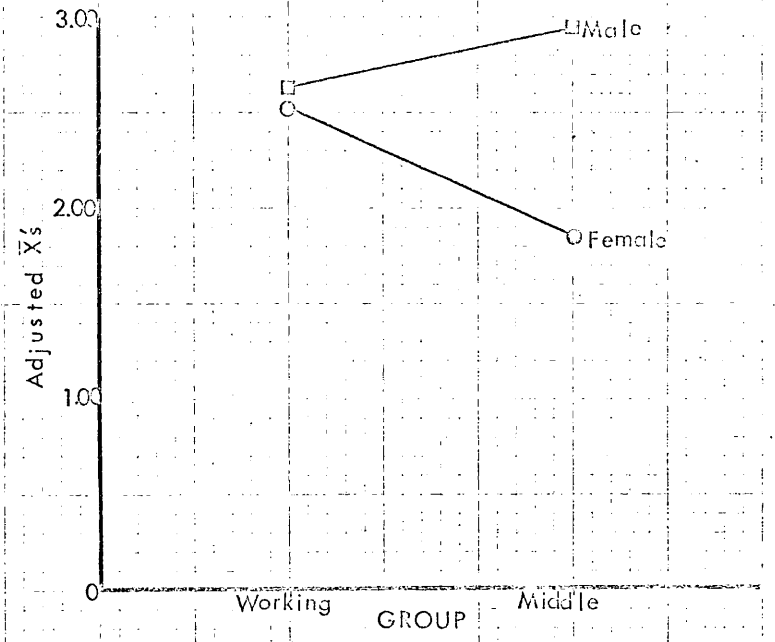

Figure 16. Adjusted S x G x R interaction for analysis of covariance: S x G aspect under nonmaterial reward.

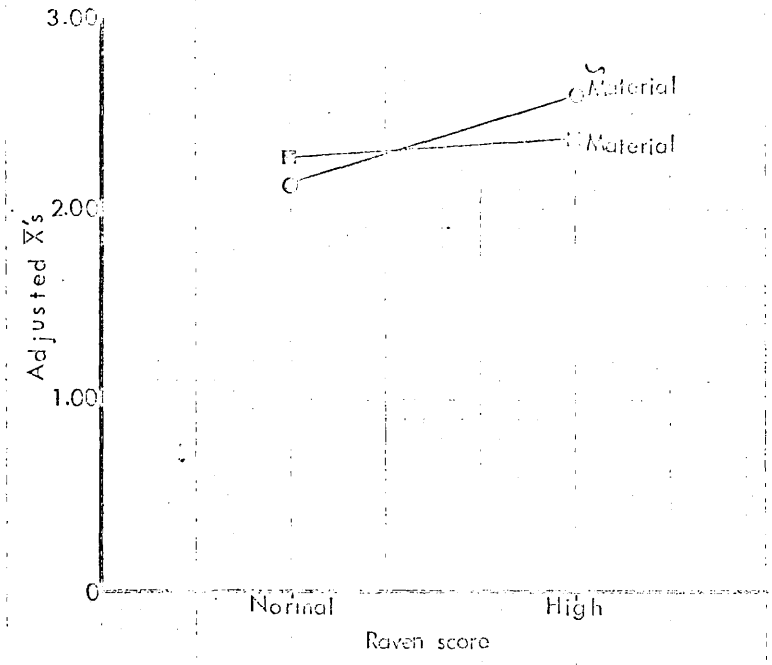

Figure 17. Adjusted I x R x Sh interaction for analysis of covariance: I x R aspect under reversal shift condition.

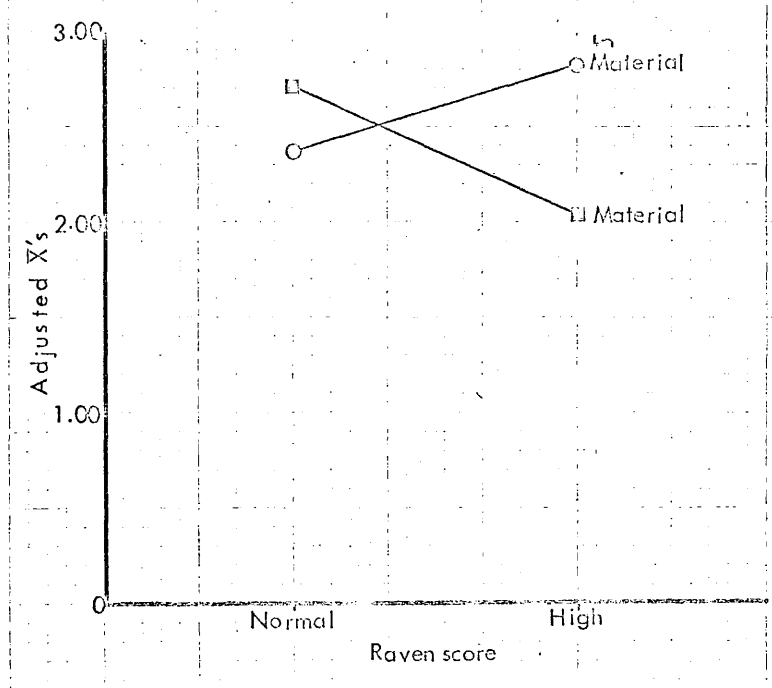

Figure 18. Adjusted I x R x Sh interaction for analysis of covariance: I x R aspect under nonreversal shift condition.

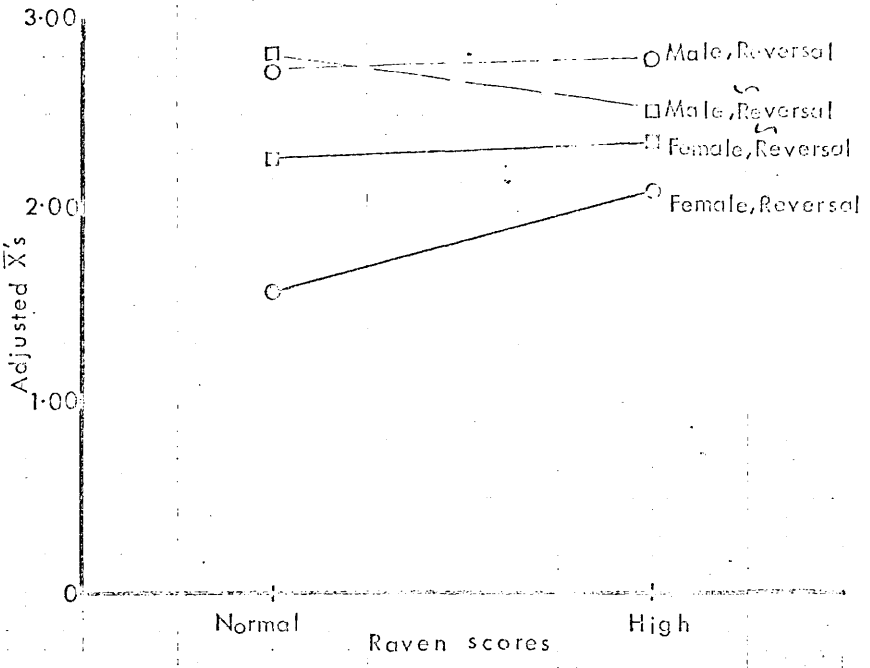

Figure 19. Adjusted I x S x Sh interaction for analysis of covariance: I x S aspect for both sexes.

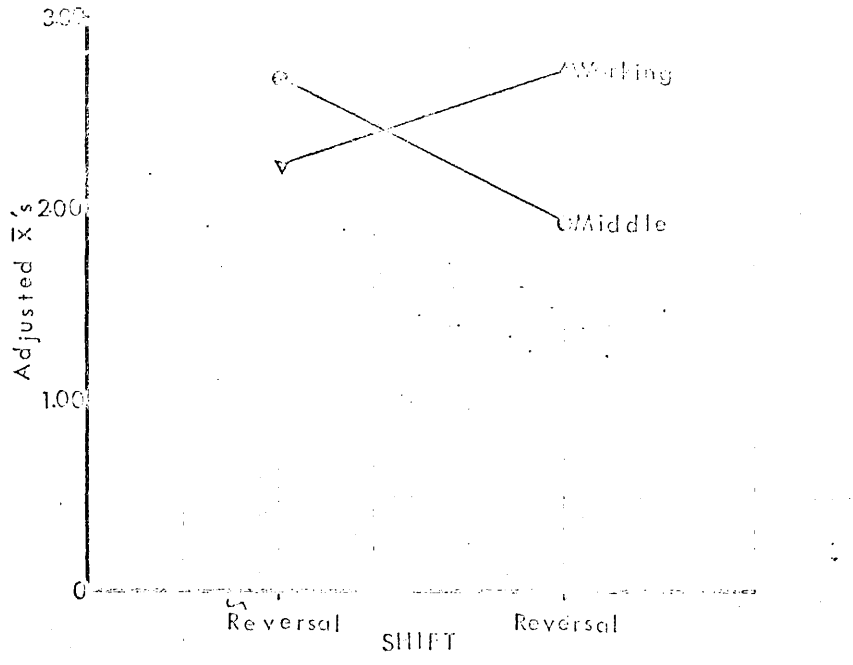

Figure 20. Adjusted G x SH interaction from analysis of covariance.

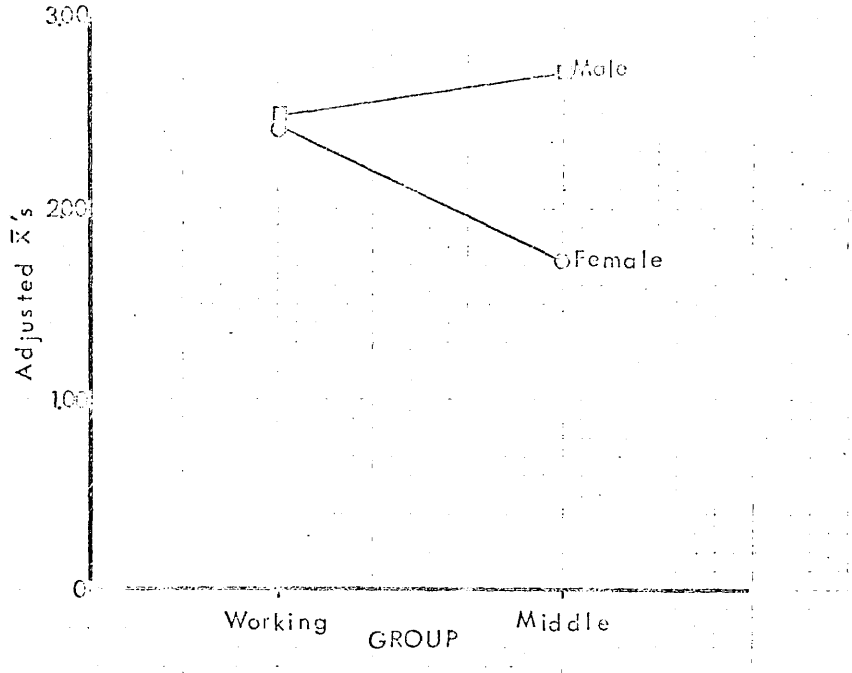

Figure 21. Adjusted S x G interaction from analysis of covariance.