Some Experiments in the Use of the 'Touch Tutor' with Severely Subnormal Children

by

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Abstract

The purpose of the present work is to examine critically some of the factors involved in the use of a matching to sample teaching machine (the 'Touch Tutor') in the everyday teaching of severely mentally subnormal (S.S.N.) children. Two factors prompted this evaluation. Firstly, it was felt that too little attention had previously been paid to the possible benefits which could accrue from the use of teaching machines with these children. When, however, this machine appeared commercially and began to be purchased by some authorities for use in Special Schools, it was felt that the widespread adoption of such a technique was over-hasty. The second factor was, therefore, that too little was known about how valuable such a machine could be for its purchase to be warranted.

The evaluation is begun by examining the results of studies with machines of similar design with young normal and mentally handicapped children and with adult, aphasic patients. These studies suggest the broad applicability of a machine such as the Touch Tutor to the S.S.N. child but contain little detail with which to judge the full extent of this likely applicability. Thus, it is hard to tell for how many such children the machine would be attractive, how many children would be able to operate the machine correctly, whether teachers would be able to incorporate such a machine into their everyday teaching and what range of skills the machine could be used to teach. Since all of these factors would appear to represent important pre-conditions of use for such a machine, the evaluation proceeds by reporting the responses of two groups of S.S.N. children in residential care to the Touch Tutor.

Preliminary observations suggest that the majority of children find the Touch Tutor attractive but that a much smaller number are able to operate it correctly in the early stages of its use. In addition, children who do not respond to it correctly engage in a number of complex patterns of responding which defy explanation.

More systematic study of the responses of children to the Touch Tutor enables a more accurate picture to be gained of the responsiveness of children to the machine and study is then directed to the use of the Touch Tutor in a school classroom. This suggests that one of the major drawbacks to the machine's use is the paucity of programme material available for it, which prompts the consideration of the problems of

developing further such material for the machine.

On the basis of this evaluation, it seems that the Touch Tutor could be a reasonable proposition for a Special School in terms of the numbers of children who would want and be able to use it but that a major drawback to its use would be the narrow range of programme material likely to be available for it, this being not only a function of the present lack of teaching programmes but also of the difficulty of envisaging subject matter which the machine could teach, as well as the difficulty and expense involved in the physical manufacture. of programme material.

Because, however, it is felt that the use of a teaching machine could offer something valuable to S.S.N. children (even 'though no specific attempt to evaluate this has been made in the present work) the possibility of using a similar but cheaper machine, for which programmes might be easier to devise and produce, is considered.

The work ends with the belief that further work upon the educational merit of different aspects of classroom apparatus and methods could prove a valuable first step to the possibily logical development of the present work - that of attempting to compare the effectiveness of such a device as the Touch Tutor to methods at present in use.

CHAPTER I: INTRODUCTION

There have been many developments in education since the last war but to those interested in the welfare of the severely mentally subnormal child there are two in particular which are interesting and important. One is the increase in knowledge concerning the education of these children. The other is the increasing use of teaching machines in many fields of education. In many ways the use of the latter can be thought of as having considerable potential for the improvement of the former but it is noteworthy that few studies have been carried out into the use of teaching machines with severely subnormal (S.S.N.) children, even though many other branches of education have found these devices helpful. This thesis represents an attempt to remedy this deficiency by examining both theoretically and experimentally some of the important factors relating to the use of teaching machines in the education of S.S.N. children. In this first, introductory chapter some of the reasons for suggesting the use of teaching machines with such people will be explained and an outline plan of the thesis presented.

Teaching machines and educational practice.

In 1954 and in other publications later (1958, 1961a) Skinner suggested a pattern for educational reform in American schools which has since had considerable impact in many areas of education. Skinner began by complaining that teachers were neither realising much of the academic potential students possessed nor creating academic enthusiasm in them. The reason, as he saw it, was that the teachers' methods ignored the effects on learning of correct contingencies of reinforcement and of the optimum presentation of subject matter. Teaching in large groups with few positive reinforcers available to students meant that reinforcement rarely occurred, rarely made contact with the response it should encourage and was rarely matched by teaching material equally suited to all members of the class.

Skinner's remedy was for teaching machines to be made available for students to work with individually. These would be devices which presented a prepared sequence of problems (the teaching 'programme') to the child, each one (or 'frame') of which would require of the child an overt response. The machine would provide reinforcement after each correct overt response the child made and, since the difficulty of these problems in successive frames would increase but slightly (the 'step-size' being thus small), the child's academic behaviour would be 'shaped' in successive approximations by the frequent reinforcement from what he knew to what it was desired for him to know. The 'teaching machine' would, moreover, provide a record of errors made by children so that the effectiveness of teaching programmes could, by revisions to them done by the teacher, be maximised. They would have, too, the advantage of allowing the student to work at his own pace, rather than at the pace of the whole class. According to Skinner, teaching machines would, by these characteristics, increase 'academic motivation' in the student by making learning more pleasurable, realise more of his potential by teaching more efficiently and have the additional advantage of increasing the amount of time the teacher could devote to her students by removing from her the necessity of repetitious drill work. In short, according to Skinner, they would remedy the deficiencies of classroom teaching prevalent at the time.

The effect of these proposals was to stimulate excitement and interest in education in the idea of 'programmed instruction'. Yet the interest was not in every respect of Skinner's proposals but rather in two particular aspects of them.

Firstly there was interest in the idea of the teaching machine itself, as a new part of classroom life. Even those psychologists and educators who did not profess to agree with Skinner's emphasis on the need for frequent and carefully arranged reinforcement in learning seemed to agree with the idea of the teaching machine, for new educational ideas which centred on more or less automatic devices arose from persons who had not voiced them before. Alternative ideas about the optimum ways of arranging and presenting subject matter were formulated (of which perhaps the most influential were those of Crowder (e.g. 1960, 1961, 1962) who advocated the use of 'branching' programme material in which errors made by students led to 'remedial' frames, in contrast to the error-free, 'linear' programme advocated by Skinner), and appropriate machines were made for the programmes inspired by them. The number of workers involved in programmed instruction methods rose sharply, as did the number of branches of education which were finding a place in their battery of methods for some type or other of teaching machine device (Hartley, 1964). The "programmed book" appeared but more as a simplified and cheaper machine than as an alternative to one. Even to-day, when the doctrine of 'programmed instruction' professes to be less concerned than ever before to discuss the merits and demerits of particular theories and methods of instruction and anxious to rid itself of the idea that programmed instruction <u>is</u> a teaching machine (Rowntree, 1969), does the appeal still seem to grip strongly. Rowntree's plea, for example, is the foreword of an extensive catalogue of 'programmes in print', teaching machines, and audio-visual devices. The teaching machine would seem, therefore, to have become a fairly well-accepted part of the possible armament of educational aids which are available to educators in many educational fields.

Yet it is important to remember that this acceptance of the idea of the teaching machine, <u>per se</u>, was not so important in Skinner's original proposal. He did not want the idea of using a machine to lead people away from what he believed was the important essential in teaching - due attention being paid to the role of reinforcement and the presentation of teaching material. The machine's advantages <u>were</u> advantages because of the improvement they effected on the contingencies of reinforcement present during learning and because in preparing materials for them the teacher had to consider the <u>effectiveness</u> of her teaching. The machine had no real advantage on its own. Even so, to many people the general appeal of Skinner's proposals lay more in the idea of the <u>teaching machine</u> than in either of these more 'technical' factors. But once the controversy over different types of machine - and programme - design between those concerned with the 'technical' aspects of his proposals died down the machine itself seemed to become less central in the minds of these people and they began to consider much more the second main aspect of his proposal which we are considering here - that is, the belief that teaching is the responsibility of the teacher, not of the pupil.

This second aspect had had a long history. Before turning to the field of human education Skinner had devoted himself to an analysis of animal learning. In the course of his experiments (Skinner, 1938; Ferster and Skinner, 1957) he had satisfied himself that a number of variables were decisively important in determining whether an animal would learn a particular item of behaviour. He claimed that by manipulating these variables precisely animals could be taught a wider range of complex skills than might be thought possible and backed up his claim by graphic illustrations of pigeons in particular performing skillful and demanding tasks. The most famous of these demonstrations is that of the pigeons who could play at 'ping pong', and the training of pigeons to guide an armed missile by pecking appropriately at the image of the target on a screen inside the missile (1961b). Some visitors to Skinner's laboratories apparently once remarked that Skinner was fortunate to have found such clever animals for his experiments. Skinner replied that of course his animals were not exceptionally clever; the fact that they were able to perform such unusual tasks to a high degree of competence was due to the way in which they had been trained. To Skinner it followed from an observation such as this that the methods he was using for training the animals was realizing in them a potential which had hitherto been unrevealed. It had been common to regard them as incapable of performing such tasks - but it was quite clear that with suitable training they were capable. It followed that when an animal did not learn a particular skill a likely reason was (rather than that it was mentally incapable of learning it) that it had not been taught correctly. Most probably, for Skinner, this meant that the reinforcements available to the animal during learning had been manipulated incorrectly.

When Skinner turned to an analysis of the methods of teaching in American schools and believed that he saw shortcomings in them, particularly with respect to the factors of reinforcement and presentation of subject matter, it was probably natural to see parallels with his animal work and believe that the teachers were failing to raise pupils to the heights they could be capable of achieving.

Thus the doctrine that teachers could raise students to higher levels of academic ability by paying more attention to the way they taught than to supposed laziness or unco-operativeness on the part of the pupil can be seen to have its roots in his work with animals. It is, of the different parts of his proposals, the one which is most fashionable today. The programmed instructor is supposed to think now of teaching objectives, of his students and the knowledge and skills they bring to him, of the methods available to him for teaching (of which the teaching machine and programme is but one) and of how he can make his teaching more efficient. Rowntree (op. cit.) expands on the theme, as do others(e.g. Bajpai and Leedham, 1970). Some like to call this the 'systems approach' to teaching and it has become quite formalized. Rowntree describes the approach thus:

> "... programmed learning's real contribution to education will not lie in the churning out of X million frames of programmes or Y million tons of teaching machines, but in breathing the scientific spirit into the technology of education. Such a guiding discipline is essential if we are to transform the present 'tools technology' (with its emphasis on individual bits of hard-ware) into a 'systems technology' in which both old and new media can be selected and combined to form teaching 'packages', each of which is a self testing, self correcting system." (Page 12). (Rowntree's emphasis).

To Skinner, therefore, the teaching machine was a device by which some of the deficiencies of classroom instruction, as he saw them, could be remedied. A machine together with a suitable programme of teaching material offered a means of effecting control over the presentation of reinforcement to the pupil during learning and over the way in which subject matter was presented to the child. But this latter advantage related essentially to the teacher. She had the opportunity to consider the ability of individual pupils (for they would work individually, at their own speed, with a teaching machine) when preparing lessons and, perhaps more importantly, was able to determine just how successful her teaching had been (for the machine provided permanent records of errors made by children revealing at which points the teacher was failing to communicate the subject matter to her pupils). Armed with this knowledge, she was able to revise her teaching programme, so as to teach more efficiently. If a child had not learned it was her fault for teaching poorly, not the child's for being lazy or 'dim'. Subsequent workers developed the idea of the teaching machine, although not completely in line with Skinner's proposals concerning the role of reinforcement, so that they are now used in many branches of education. His emphasis on the need for teaching to be thought of as the responsibility of the teacher rather than of the child has also become popular, and in some quarters is vying with the teaching machine for acceptance as the definitive feature of the doctrine of 'programmed instruction'.

Educational thought in the treatment of the severely mentally subnormal.

The most interesting feature of educational thought relating to S.S.N. people at this time is the realization, remarkable perhaps to us now, that such people were capable of more skilful behavior than had been thought. The traditional academic picture of the imbecile person, formed by many years of little research and little positive thinking concerning the subnormal, was pessimistic. Supposedly lacking in dexterity and co-ordination, in discriminative ability, perseverance and many other qualities the outlook for the severe subnormal's future was invariably bleak. Consider the statement by Lewis (1929) who, according to Tizard (1965) "carried out the most thorough large scale investigation into the prevalence of mental deficiency which has, as yet, been made in any country." (p.9):

> " The best that can be expected of them is the simplest of routine tasks under supervision .... the brightest can usually wash and dress themselves, but only learn to do so very late in childhood, and such matters as buttoning boots or tying shoelaces often remain entirely beyond their powers." (quoted in Tizard, op.cit. page 10.)

It was not until the 1950's that such views as these of the imbecile person began to change. With experiments such as those by Loos and Tizard (1955), Clarke and Hermelin (1955), and Gordon et al. (1954, 1955), it rapidly became clear that the traditional picture of the imbecile adult was unduly pessimistic. True, it described adults who had received no training fairly well, but it bore little resemblance to the same people after suitable training in appropriate tasks. Clarke and Clarke point out:

> "It is clear that traditional clinical opinions of imbeciles are reasonably accurate descriptions of their abilities before training, but to take them at their face-value is to ignore their potentialities. Many could perform useful tasks and contribute substantially to their own support, in national conditions of full employment, provided that their physical handicap is not severe." (1965, p.364).

The effect of these crucial and illustrative experiments was to stimulate in many people a belief in the value of education in the treatment of severely subnormal persons. These studies had shown that appropriate teaching could reveal a hitherto unrealized potential in imbecile persons; they implied that a greater potential could be realized with the investment of more time for teaching and of more skilful teaching methods.

From this time on we see an increased emphasis being placed upon the role education should play for such people, with both research workers and the public authorities responsible for organizing subnormality services taking on an increasingly optimistic view of the heights such people might be able to reach. As in many things such a change of opinion took time but it appears to have been progressive, probably reinforced periodically by reports of striking educational successes with certain persons or groups of persons. Thus the reports of the effect of the Brooklands residential unit on the children who stayed there during the comparatively short course of the experiment (Tizard, 1964), of the achievements of Nigel Hunt (1967); of the adult with a M.A. of below two years reported by Gunzburg (1968, pp.187-188) who having held down a job in a laundry situated in the community for many years, had to master the intricacies of a long bus journey to work after being moved to a subnormality hospital; and of other less well-documented reports, all have served to remind people of the premise laid down in the course of the experiments of the 1950's cited above - that until such persons have been given a chance to learn, by being given appropriate teaching, an adequate estimate of their potentialities cannot be obtained.

Similarities clearly exist between the aims of and rationale behind the use of teaching machines and those underlying the education of the severely subnormal at this time. Both were emphasising the probable under-achievement of students; both were stressing the need for the teacher to adapt herself to the students' needs in order to bring out their potential. Different areas of education were adopting teaching machines and developing them for use with their own teaching problems in mind. We might expect that those concerned with the education of the severely subnormal in both Britain and America would have been inspired by this similarity in approach to investigate closely the possibility of using teaching machines in their area of education, especially in view of the overall paucity of knowledge and techniques relevant to their educational needs. To a certain extent this did occur, albeit slowly, in America; British interest, on the other hand, was extremely cool.

<u>The application of teaching machine concepts to the education of the severely subnormal in Britain and in the U.S.A.</u>

The first published study of a teaching machine for severely subnormal persons appeared in the mid-1960's, approximately 12 years after the appearance of Skinner's first paper. In the study, Sidman and Stoddard described the development of a machine to teach skills of perceptual discrimination to pre-school and to S.S.N. children (1966) and made a more extensive analysis of the teaching system with relation to S.S.N. children in particular in a later paper (1967). In the following two years, Friedlander <u>et al</u>. (1967) announced preliminary studies of a machine for institutionalized, very young children and Bijou (1968) announced extensive studies of a machine he had used with young pre-school normal children and brief work with the same system and a group of children with I.Q's ranging from 33-66.

Thus the application of teaching machine principles to the education of the severely subnormal had only begun to get under way by 1968 - at least in the research literature. And in America, for few mentions of the use or possible value of teaching machine principles in the education of the S.S.N. have been made in Britain (to the writer's knowledge) even up to the present day.

This neglect of the application of programmed instruction principles to the education of the S.S.N. is made more pronounced by, on the one hand, attention paid to them in relation to the education of the mildly subnormal and,on the other, by the attention which has been paid to the use of operant conditioning techniques with the S.S.N. during the last 12 years. In relation to the former at least six major reviews and an annotated bibliography of studies in the use of teaching machines and programmed instruction with the mildly subnormal have appeared. In these reviews (Stolurow, 1960a,b, 1961; Greene 1966; Haskell, 1966; Malpass,1967) and in the bibliography (Dodd and England, 1965) approximately 54 studies (of which approximately 38 are unpublished manuscripts or technical reports) are cited in which teaching machines are used to teach, mainly, reading, spelling and arithmetic skills to children who have possessed some ability in these subjects. While the reader is referred to these reviews for a more detailed consideration of the studies, it is of interest here to note that the majority of these studies have used children with I.Q.'s in the range 50-80, have used machines of simple, often manually-operated construction, and have made evaluations of reading, arithmetic or writing programmes used with such machines either against conventional teaching methods or between different formats of the same programmes. Although, as noted by Greene (1966), who is the most critical reviewer, it is generally hard to conclude much about what particular programme or machine variables are important in such learning, whether many children can properly operate the machines used, and what the effects of programmes for children of differing M.A. or I.Q. may be, it does seem that mildy retarded children in general can learn from and respond to this kind of approach.

Studies in the application of operant conditioning techniques to the S.S.N. have fallen into two broad groups. On the one hand, there have been a number of studies in which reinforcement has been systematically administered in order to generate or modify specific forms of behaviour usually of a social kind, such as feeding, dressing and toileting (these may be termed 'behaviour modification studies) while on the other hand there have been studies conducted with the kind of operant apparatus typically associated with animal studies in which the characteristics of free operant behaviour have been examined.

Reviews of both 'behaviour modification' and 'free operant' studies are available (Headrick, 1963b; Spradlin and Girardeau, 1966; Baumeister, 1967; Weisberg, 1971) in which approximately 41 'behaviour modification' and 18 'free operant' studies of the use of such techniques are cited, all of which are published papers. With regard to the latter kind of study, which is of more immediate relevance to the present discussion than the former, it would seem that S.S.N. people in general work well in conditions in which sweets or tokens for subsequent exchange are obtainable at the oppropriate manipulation of a lever, that they are sensitive to the effects of different schedules of reinforcement and, of great important in relation to the use of teaching machines with such people, that they respond well to tasks requiring behaviour to be conditional on the presence of some specific stimulus. Examples of these studies are those of House _et al_. (1957); Ellis _et al_. (1960); Orlando and Bijou (1960); Bijou and Orlando (1961); Ellis (1962); Spradlin (1962); and Headrick (1963a) who investigated changes in the characteristics of the responding of children and adults in institutions for the subnormal in America under different schedules of reinforcement and those of Orlando (1961); Barrett and Lindsley (1962) and Orlando and Bijou (_op. cit._) who studied, with similar subjects, the development of stimulus control in tasks in which reinforcement could be obtained when, for example, a light of a certain colour was shining. The general findings of these studies, in which the subjects used have both been children and adults whose I.Q.'s have ranged from below 20 to over 70, have bean that many S.S.N. people can learn during such procedures, providing that suitable operant responses and reinforcements can be found for them, and that some regularity in their behaviour can occur under different reinforcement schedules - both these aimed at producing characteristic response behaviour under reward schedules alone and those aimed at ganerating stimulus control. On the other hand it has been difficult to develop such control in all subjects, as is ultimately the aim of such workers, and large inter-subject variability in responding (apparently unlike rats and pigeons) has disturbed some workers. Strangely, this kind of study, characteristic particularly of the first hald of the last decade, has ceased in favour of 'behaviour modification' studies; some studies have persisted and have had a more immediately 'practical' flavour - Bricker and Bricker (1969) used, for example, the operant method to conduct pure-tone audiometry in S.S.N. persons; Watson et al. (1968), wishing to know for how long operant responding could be maintained, attempted to gauge the long term preferences of subjects for different kinds of reinforcement in a plunger-pulling task - but few studies in 'free operant' responding now appear.

Characteristic of these operant and teaching machine studies is the optimistic tone they adopt concerning the value of these approaches for the two groups of subjects; they have seen in these methods the possibility of achieving greater educational successes with such people than had hitherto been possible reflecting, by such conclusions, the optimistic tones of Skinner. As examples, a quotation from the review of Malpass and the concluding remarks of the review paper of Spradlin and Girardeau may be cited.

Malpass (1967) believed:

"Research clearly suggests that retarded children can learn more, and better and faster, by programmed instruction than by conventional EMR classroom techniques. In addition, this research suggests that such improvement in learning is related to the presentation, repetition, and feedback conditions that are characteristic of effective programming." (p.226)

Spradlin and Girardeau (1966) conclude their review:

"In cases where operant techniques have been applied, the reported results are encouraging. One might hope that these advances would lead to the development of training and educational programmes which one day would allow these persons to live in and contribute to the noninstitutional community. The extent to which such a goal is accomplished depends primarily on the ingenuity and effort of interested workers.

The present writers believe that if the principles and techniques discussed in this chapter were consistently applied, Butterfield's (1961) case of overachievement by a mongoloid might be considered 'typical' rather than a 'provocative case'." (p.294)

Such optimism about the results of 'free operant' and teaching machine studies with the severely and mildly retarded might lead one to expect that the application of teaching machine and programmed instruction principles to the education of the severely subnormal would be an educationally valuable exercise. Yet, as we have seen, there have been few studies of teaching machines with such people and little discussion of the value of such an approach. Similarly, the fact that studies in the use of a Skinnerian teaching machine with appropriate programme material with brain-damaged, adult patients (Filby and Edwards, 1963; Filby et al., 1963; Rosenberg and Edwards, 1965; Edwards and Rosenberg, 1966) some of whom, they point out, were so severely affected that: "they were completely speechless, incapable of responding appropriately to simple spoken commands (such as, 'Point to the pencil'), incontinent of urine ... and confined to a wheel chair." (Filby and Edwards, 1963, p.32), have led the authors to see educational potential in their subjects which had previously been unrecognized, suggests at the very least that such methods are worthy of wider study.

In short there had been, when the present thesis was conceived in 1968, a dearth of studies in the application of teaching machine concepts to the education of the severely mentally subnormal which, in view of the educational thought prevalent for some years concerning the education of such people, and in view of apparent successes with similar methods with other groups of people and of the related techniques of operant conditioning with the S.S.N., was generally surprising. There did thus seem to exist a powerful argument on behalf of further work and critical discussion to expand the knowledge already generated by the few studies cited at the beginning of this section which had been performed on the use of teaching machines with the S.S.N.

On the other hand there could be seen a danger in the over-enthusiastic pursuit of teaching machines for use by the S.S.N. Although Sidman and Stoddard (1967) had been inclined to say, after using stimulus 'fading' (see page 25) procedures in relation to the discrimination of forms by S.S.N. children, based on a teaching machine:

"The success, with retarded children, of a teaching method that reduced errors .... should not be interpreted as meaning that retarded children are simply the products of inadequate instruction. A more valid inference is that their capabilities have been underestimated. More effective instructional procedures than those in general use are available to estimate the behavioural potential in children limited by developmental or acquired abnormalities." (pp.14-15), they had used an expensive and complex set of equipment which was in the early stages of its development. This is not to say that their approach was not worthy of further development (indeed Sidman and Stoddard's work was stimulating and original), merely that some more detailed appraisal of its potential value was needed before adopting their techniques on a wider scale. Similar considerations apply, too, to the other studies with the S.S.N. noted above, in which teaching machines were used. Friedlander _et al_. (1967) believed:

"PLAYTEST procedures offer advantages hitherto largely unavailable in evaluating sensorimotor abilities in severely handicapped infants and young children." (p.918) but a similar criticism can be made of this work to that of Sidman and Stoddard.

Such a critical view of the success of procedures based on operant conditioning techniques is not unjustified. To the writer's knowledge there have been few, if any, attempts to consider operant techniques in terms of their everyday applicability and cost and to compare them in these respects with more 'traditional' forms of instruction. It is enlightening, in this respect, to compare the claims of success which have been made when operant techniques have been used with those of a study of Cortazzi (1969). She demonstrated that the diligent application of 'nursery school' methods, systematically and repeatedly applied, were effective in promoting patients from 'low grade' status in a subnormality hospital to participation in conventional occupational therapy and in other respects of social life in the hospital.

Before 1968 there appeared to be little danger that an over-enthusiastic pursuit of teaching machines would occur, so that any critical evaluation of their use would have been principally of academic interest, despite the clearly important practical implications it would have had. In 1968, however, this position changed radically with the introduction of the technical means for educational bodies to apply teaching machine concepts to the education of the S.S.N., in the shape of the 'Touch Tutor' (Clearly and Packham, 1968a,b,c). This was a self-contained, free-standing, largely 'child-proof' machine which was apparently suitable for the S.S.N. in that it did not require either fine motor dexterity, or the ability to read, for its operation. In addition, it appeared attractive to such persons and embodied 'Skinnerian' teaching machine principles. It is not surprising that after the optimistic conclusions of teaching machine studies in other branches of education and with the S.S.N., and amidst a generally sympathetic educational climate, several of the authorities concerned with the education of the S.S.N. should rush to buy these machines - and did so. It was at this juncture that the present thesis was conceived for it appeared that the time was ripe (with an appropriate machine being commercially available) to devote effort to a critical look at the possible value of the use of teaching machines in the education of the S.S.N. In this respect it was decided to concentrate this effort specifically on the 'Touch Tutor'; for this machine was not only fundamentally similar to previous machines in its use of 'matching to sample' as a means of presenting teaching material (see Chapters 4 and 9) and in its essentially Skinnerian design, but was commercially available. It was hoped that the results obtained in such study of it would, therefore, not only serve as an evaluation of this particular machine, but also as an evaluation of the use of similar machines. Let us now consider how this 'evaluation' might proceed.

Plan of the thesis

It was the present writer's belief that there was a need for the psychologist interested in the education of the S.S.N. to concern himself directly with the problems of the everyday education of the S.S.N., a belief which had been strengthened by Clarke's plea (1966, 1969) that interested psychologists should work to expand and disseminate the considerable work that has emerged from the literature on the education of the S.S.N., as well as by Gunzburg's occasional condemnation of 'theoretical' research work (c/f Gunzburg, 1972) in this field. Accordingly the primary aim of the present intended analysis of the value of teaching machines like the Touch Tutor in the education of the S.S.N. child ought, it would seem, to be towards the use of them by teachers in their everyday classroom work. To this end, the writer devised an analysis of the parameters of use of educational apparatus in general in the S.S.N. classroom (presented in Chapter 8 of this volume) with which to guide the analysis. This suggested that if the advantages Skinner envisaged for the teaching machine in education, and which he envisaged for the young normal or handicapped child (Skinner, 1961a) namely, that teaching machines like the Touch Tutor: (1) offer the opportunity of a systematically planned learning experience in the form of a gradually progressive, revised teaching programme in which the student progresses by short steps from what he knows to what it is desired for him to know, during which (2) reinforcement is frequent and clearly contingent upon correct responses made by the child; (3) offer instruction which is individual, the learner proceeding at his own pace; (4) enable the teacher to be relieved from that part of teaching which is repetitious drill work and (5) teach discriminations, which are essential for academic competence, more effectively than can a human teacher, are to be attained then five major conditions of their use needed to be fulfilled. These five conditions were: (1) that a machine appropriate to these aims was available for use; (2) that children would find such a machine attractive to use (3);that they possessed the skills required to operate it; (4) that teachers were able to use it in their classrooms and (5) that sufficient programme material was available for the machine.

It is necessary to realize that, simple as these points may seem, there was no evidence in 1968 that these prerequisites of use would be fulfilled by the Touch Tutor or machines similar to it in relation to the S.S.N. child. Therefore, it was resolved to aim the present work at determining the extent to which the Touch Tutor fitted these five conditions. The main body of this thesis discusses these five points and related problems. The work is divided into 10 chapters. Chapters 2 and 3 review work with machines similar to the Touch Tutor with, in Chapter 2, young normal children at either pre-school level or who are in their first years of infant school and, in Chapter 3, with mildly subnormal and severely subnormal children and with adult, brain-damaged patients. Chapter 4 presents a descriptive account of the operation of the Touch Tutor machine itself and critical accounts of studies conducted with the machine by its originators. Chapter 5 presents details of preliminary work conducted by the present author with the Touch Tutor and Chapters 6,7 and 8 describe the continuation of this work aimed at determining both in the laboratory and in the class-room the number of children able to use the machine, how attractive to use they find it and the teacher's response to its presence. Other aspects of the children's response to the task presented by the machine of 'matching to sample' are also considered in these chapters. Chapter 9 contains a discussion of the development of teaching materials for the machine while Chapter 10 contains a general discussion of the thesis in the light of its aims as developed in this Chapter.

CHAPTER 2: STUDIES IN THE USE OF TEACHING MACHINES WITH YOUNG NORMAL CHILDREN

(1) Introduction

We saw in Chapter 1 that few studies in the use of teaching machines with S.S.N. children had been performed. Accordingly there are few which may be used as background to the present work. Therefore we may fruitfully ask whether studies conducted with different experimental subjects could be sufficiently relevant to be of any value to us in this respect.

There are in fact a number of studies in which teaching machines which, like the Touch Tutor, emply the principle of matching to sample for the presentation of subject matter and which, again like the Touch Tutor, are essentially Skinnerian in emphasis. Three main groups of such studies occur in the literature, namely, studies with mildly subnormal children, studies with adult aphasic patients and studies with pre-school and primary normal children. Although these studies are with groups of subjects whose educational problems may be very different than those which are presented by the S.S.N. the fact that information about the use of matching to sample machines is available with subjects for whom conventional machines requiring the ability to read or write fluently are not immediately suitable, makes a consideration of these studies worthwhile. In this Chapter studies with young normal children will be reviewed; the next Chapter will review studies with adult aphasic patients, with the mildly subnormal, and the relevant studies conducted with the S.S.N. The general plan of these reviews is to present details of each programme of research and then to discuss the work in relation to its own aims and in relation to other studies. At the end of each Chapter an overview and synthesis of the studies will be made. It may be thought that undue space is given to each study. The main reason for this is that the studies themselves are long, being presented in detail; a second reason is that for our present purposes it is a knowledge of the details of each study which is of value, rather than their overall conclusions.

(2) Skinner's idea for a machine and its influence

In one of his introductory papers to the idea of using teaching machines in education Skinner (1961a) described different kinds of teaching machines and the various rationales which underlay their use. One of them aimed to teach people to make discriminations:

> "The apparatus is adapted from research on lower organisms. It teaches an organism to discriminate selected properties of stimuli while 'matching to sample'. Pictures or words are projected on translucent windows which respond to a touch by closing circuits. A child can be made to 'look at the sample' by reinforcing him for pressing the top window. An adequate reinforcement for this response is simply the appearance of materials in the lower windows, from which a choice is to be made.
>
> The child identifies the material which corresponds to the sample in some prescribed way by pressing one of the lower windows. If he presses the wrong window, all three choices disappear until the top window has been pressed again - which means until he has looked again at the sample. Many other arrangements of responses and reinforcements are, of course, possible. In an auditory version, the child listens to a sample pattern of tones and then explores the other samples to find a match." (1961a; quotation taken from Skinner (1961c) p.182.05)

A picture of this machine is given in Figure 2.1. Skinner goes on to describe why he feels it necessary to teach a child to make discriminations:

> "We call an effective person 'discriminating'. He can tell the difference between the colours, shapes and sizes of objects .... Subtle discriminations ... are as important in science and industry and in everyday life as in identifying the school of a painter or the period of a composer." (ibid.)

But what he feels especially important is the fact that machines would be more effective in teaching discriminations than would the human teacher since:

> "The number of reinforcements required to build discriminative behaviour in the population as a whole is far beyond the capacity of teachers. Too many teachers would be needed,

Figure 2.1

A teaching machine described by Skinner (1961a) as suitable for teaching mentally handicapped and pre-school normal children to 'discriminate'. The machine was used by Hively (1962) in a study of the acquisition of matching to sample behaviour by young normal children.

and many contingencies are too subtle to be mediated by even the most skillful." (ibid.)

The machine will patiently present material which requires the child to make discriminations, reinforcing him immediately when he responds correctly. It should encourage him to pay attention to the material by virtue of this reinforcement. The subject matter the machine would teach and the effectiveness with which it would do so would, according to Skinner, have a profound educational effect:

> "If devices similar to these .... were generally available in our nursery schools and kindergartens, our children would be far more skillful in dealing with their environments. They would be more productive in their work, more sensitive to art and music, better at sports, and so on. They would lead more effective lives. We cannot assert this with complete confidence on the present evidence, but there is no doubt whatsoever THAT THE CONDITIONS NEEDED TO PRODUCE SUCH A STATE OF AFFAIRS ARE NOW LACKING. In the light of what we know about differential contingencies of reinforcement, the world of the young child is shamefully impoverished. And only machines will remedy this, for the required frequency and subtlety of reinforcement cannot otherwise be arranged."
> (op.cit. p.182.07; Skinner's emphasis.)

Skinner does not seem personally to have carried out much work with this machine; according to Holland (1960) he prepared a matching to sample programme designed to teach the abstract properties of form to young children, but few details of this are mentioned. These words of Skinner seem rather to be based upon the work carried out by Hively (1960, 1962) and by Long (described in Holland, 1962), although the credit for designing the machine belongs apparently to Skinner himself. He himself notes it similarity to his operant apparatus designed for use with pigeons - a picture of which is given for comparison purposes in Figure 2.2.

Having described the origins of the machine which will be with us, in various disguises, for the remainder of this thesis and its advantages, as seen by its designer, let us now investigate how the machine was used and how far it might be said that Skinner was

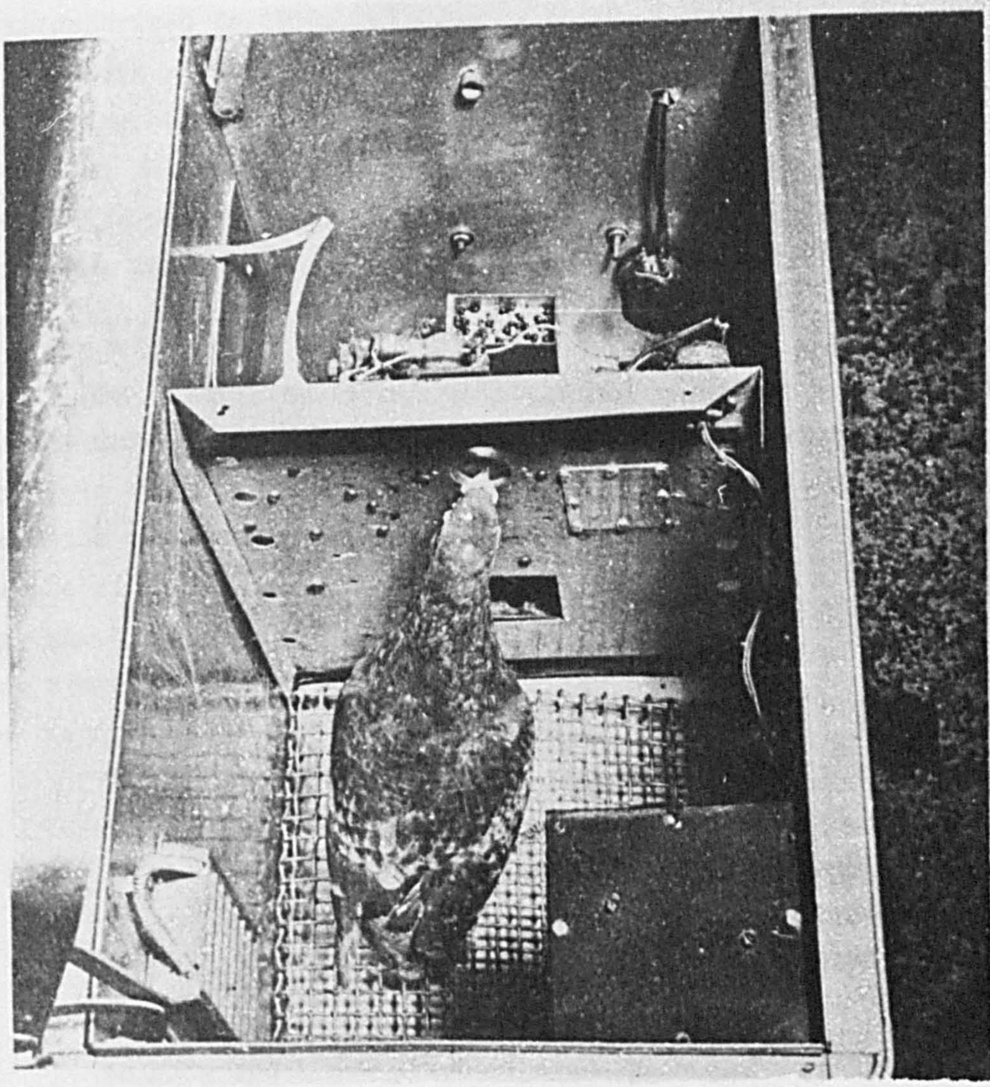


Figure 2.2

A typical 'Skinner-box' for a pigeon, illustrating the origins of the matching to sample teaching machine. The pigeon pecks the circular key, obtaining food for doing so if certain conditions are met. One such condition could be the presence of the word 'Yes' on the key. If the pigeon pecked only when 'Yes' appeared he would be showing that he had learned to discriminate between certain visual symbols.

justified in his descriptions of it.

(3) The work of Hively

Hively's work falls naturally into two phases: the first phase of work is described in his first paper in 1960 and the second is described in 1962.

Both of these pieces of research involve a matching to sample teaching machine and both involve young children of normal ability. They differ in emphasis and in a number of details only, but these differences enable the reader to think of the two pieces of work as separate.

(i) Hively's First Study

The "main purpose" of Hively's first programme of reseach "was to see how effectively the apparatus alone shaped and maintained the behaviour of the children." (1960, p.251, Hively's emphasis). The apparatus was a machine essentially similar to that described by Skinner above. It contained three response panels, in a triangular display, which displayed stimulus materials, delivered automatically, on cards measuring 5" x 8". The machine operated in the following manner:

> "Each time a stimulus card was presented, only the sample window was lighted. Responses to the unlighted choice windows had no effect. A response to the sample window lighted the choice windows and made them operative. When the choice windows were lighted, a response to the correct window (in which the match appeared) caused a bell to ring and a new stimulus card to be presented ... A response to the incorrect window (in which the alternative appeared) darkened the choice windows and made them inoperative. Another response to the sample window was required in order to light and activate the choice windows, another choice response could then be made, and so on." (1960, p.251)

Pictures of the machine and of the stimulus materials used with it are given in Figures 2.3 and 2.4. The teaching material was divided into two series of cards. In the first series each card carried only two pictures; in the second series each carried three pictures, thus presenting a full matching to sample task to the child.

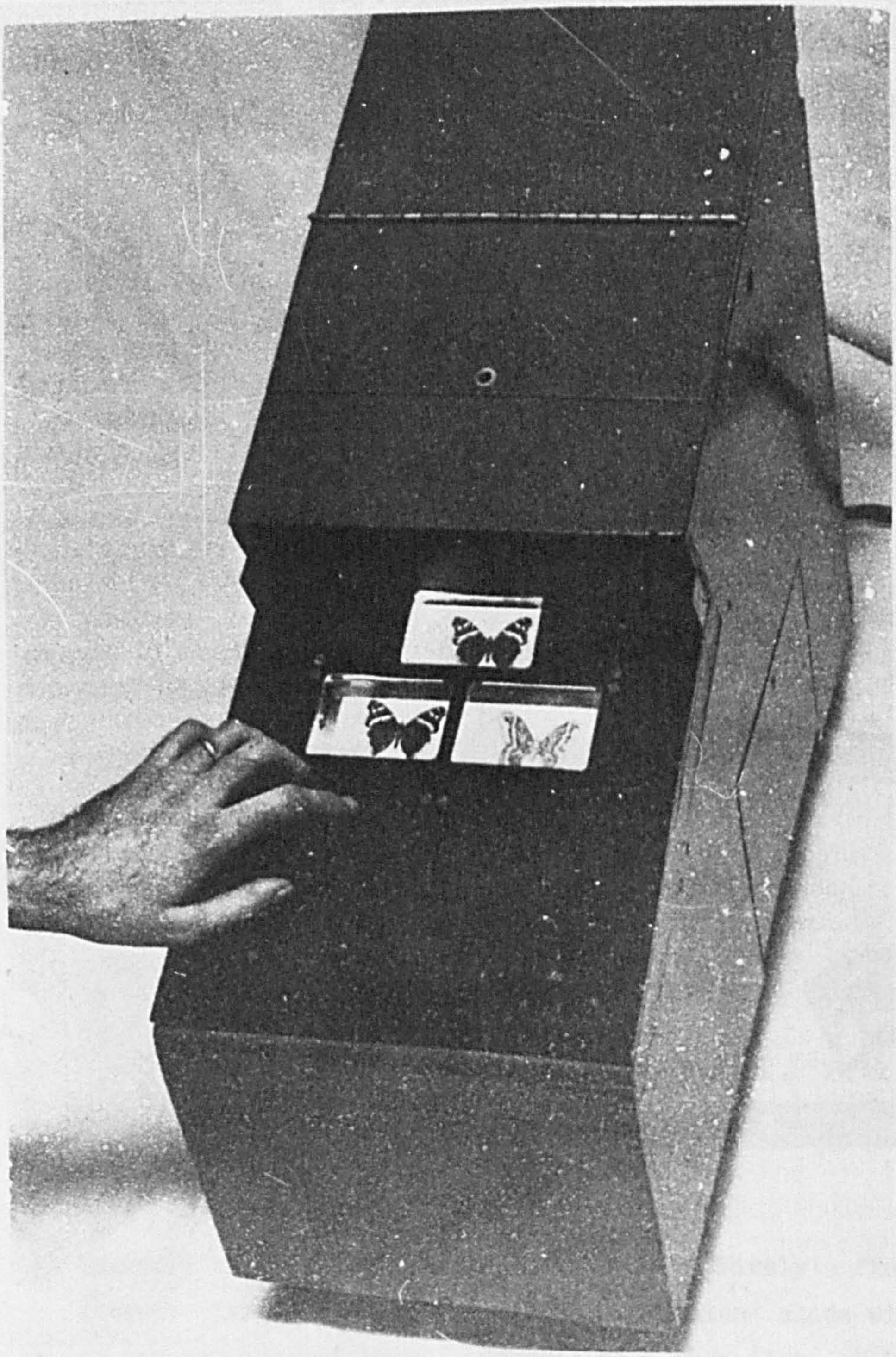


Figure 2.3

The machine used in Hively's first study (1960). See text for description of its mode of operation.

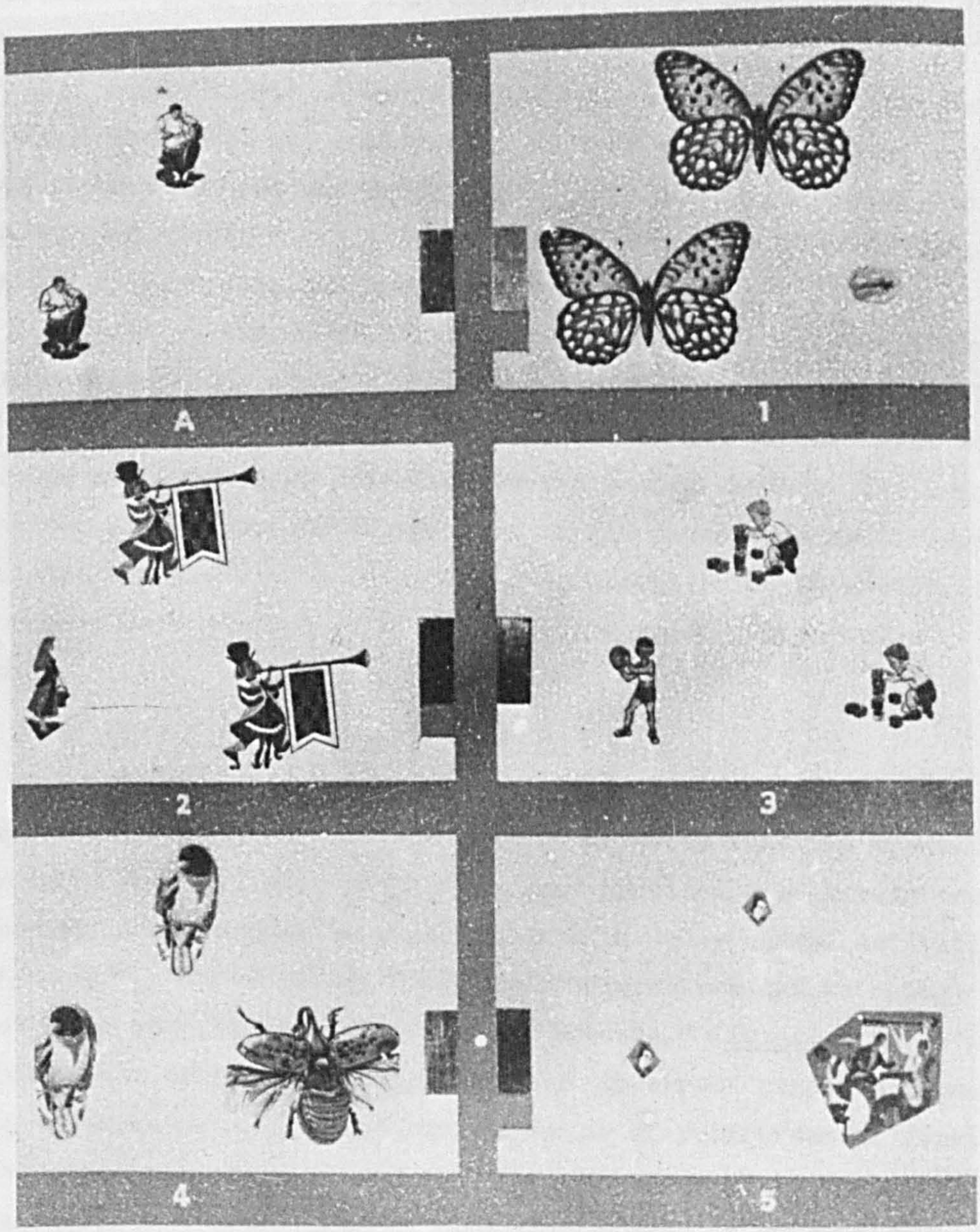


Figure 2.4

Examples of the programme material used in Hively's first study (1960). Card 'A' shows a typical 'one-choice' slide with no non-matching stimulus. Cards 1 to 5 show items of increasing difficulty in 'matching to sample' format, with the size of the non-matching stimulus increasing from relative insignificance (Cards 1 and 2) to equality in size and eventual dominance over the matching stimulus (Cards 4 and 5).

In this second series (see Figure 2.4) the incorrect stimulus item appeared faintly at the beginning and increased in prominence as the series progressed. Each series contained approximately 120 cards.

27 children of normal ability, ranging in age from 3 to 5½ years, were given the opportunity to work with the machine in their school classrooms. Hively would demonstrate the operation of the machine to an individual child until he was responding frequently to it and the leave him to play with the machine alone.

25 of the 27 children returned to work with the machine for as many sessions as were needed to finish the two series of slides. Of these children 13 achieved criterion responding on the first series of slides and 4 achieved criterion on the second series. The remainder of the children responded either to a single choice window throughout the slides, to the window which had last operated the apparatus, or they pushed both windows at once, or they responded apparently randomly.

(ii) Discussion of the First Study

Hively does not devote much discussion to an analysis of what had been achieved in the study. He notes that the apparatus "within the modest limits which were set" provided enough reinforcement to keep children working in competition with other school activities (1960, p.252). In addition, "simple discrimination and matching performances were taught with moderate success." (*ibid.*) He attributes the development of patterns of incorrect response in many of the children to accidental contingencies of reinforcement resulting from the machine's mode of operation and believes that improving the precision of this could help to eliminate them. In conclusion he notes:

> "Simple discrimination and matching performances were taught with moderate success. A number of factors which need further study are suggested - most of which involve the elimination of spurious contingencies of reinforcement. The prospect of developing an efficient 'associative discrimination teaching machine' seems good, and such a device has exciting possibilities as a means of teaching and testing the very young, the handicapped and the mentally deficient. It also offers the possibility of studying human discrimination with a degree of experimental

control comparable to that obtainable in experimentation with animals." (op.cit., p.256)

Let us now turn to Hively's second piece of published research (1962) to see how the findings of his first experiment were developed.

(iii) Hively's Second Study

The children used for this study were older than those used in the first study (5 years 8 months to 6 years 10 months) and he used a different design of machine (see Figure 2.1). While basically similar to the machine Hively used in his first study it differed and Hively does not say why, in several respects. The most marked of these was the simpler mode of operation it used. A child would see both stimulus and response stimuli illuminated before making a response. Reinforcement for correct responses was the immediate changing of the slide; incorrect responses had no effect on the machine and the child could respond again immediately if he wished.

Hively also used completely different stimulus figures. These were now four nonsense shapes, which differed systematically in size, shape and colour, and which were used in all of the teaching slides.

The starting point of this study was the result obtained with six of the children. These children were introduced to the machine by the experimenter (E.) demonstrating the operation of it and then by his encouraging the child to do the same himself. In three sessions, none of these six children learned to match the pictures correctly. Instead, they responded in various ways similar to those Hively had noticed in his first experiment. This led Hively to consider a way in which they might be taught to respond to the matching relationship and the way he decided upon was to begin with an easy discrimination which would then lead the child to the final hard discrimination through a series of 'successive approximations'. The remainder of the paper describes his attempts to create a sequence of progressively difficult discriminations, leading up to the matching to sample task required in the study at the beginning of this paper.

Hively produced, after a number of revisions, a programme of slides which seemed to teach children to match correctly. The programme contained 132 slides leading up to a criterion programme of 94 slides which contained the final, difficult discrimination. The various units of this programme of slides are given in diagrammatic form in Figure 2.5.

Hively was confident that the programme was the right length, that experimenter effect, or the children telling other children how to operate the machine was not responsible for the improved results of the various amendments of the programmes, and that leaving out the transition series of slides reduced its efficacy, by a number of short comparison experiments carried out with further children of a similar age.

(iv) Discussion of the Second Study

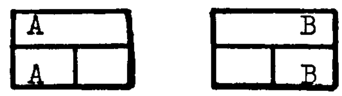
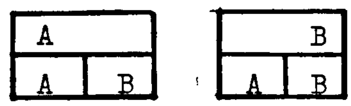
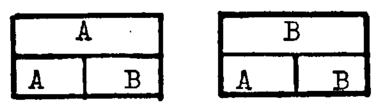
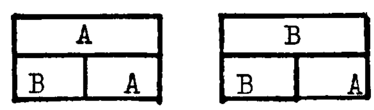
One of the most striking impressions one gains from this latter study concerns the difficulty Hively encountered in using the teaching machine with these children. Hively again attributes this difficulty to accidental contingencies of reinforcement but admits that these are not necessarily the fault of the operation of the machine; or of the arrangement of the programme slides:

> ".. no matter how carefully one designs a sequence of correlations between the occurrence of stimuli and the availability of reinforcement, the actual contingencies of reinforcement in a given case depend upon what the subject observes, which in turn depends upon the individual subject's history. From the experimenter's point of view, it is a matter of chance." (1962, p.292)

This difficulty will be made worse in a complex discrimination problem, Hively believes, because the subject is less likely to observe the relevant stimuli. The difficulty seemed to be lessened by presenting subjects with a series of progressively difficult discrimination problems. Naturally, of course, there were some problems in this. Hively notes the occurrence of errors, after long runs of correct responses, and attributes these to boredom. In other groups of subjects errors occurred, it seemed, as a result of too abrupt transitions between the different parts of the programme. What Hively does not comment upon is the difference between the two machines he used in their manner of presenting the stimuli. The mode of operation of his first machine would seem to have an advantage over the second in

Figure 2.5

Steps in Hively's (1962) teaching programme

Series	Examples
2SCO (20 slides)	
TRANSITION (24 slides)	'Fading in' incorrect response stimulus
2SC (20 slides)	
TRANSITION (16 slides)	Position of sample moved to centre position
2C (20 slides)	
2 (16 slides)	
TRANSITION (16 slides)	Introduction of two additional stimuli
4 (94 slides)	2 choice matching to sample with 4 stimuli

requiring the child to respond actively to the sample stimulus panel before responding to the lower panels. As we shall see shortly, this difference could have helped to make the matching task easier for the children, removing some of the need for Hively's detailed teaching programme.

It is difficult to see that Hively's second machine has become a device with "exciting possibilities" for teaching or testing the handicapped. Interestingly, Hively does not mention what he believes the implications of the machine for such purposes. The discussion is concerned with the implications of the work in terms of previous research in discrimination learning and in terms of the reinforcement values of the machine.

Difficult also is the belief that Hively's work with Skinner's machine justifies its maker's faith in its powers. Skinner seems to have been a little premature in saying, at least on the evidence with which Hively has presented us, that the machine is exposing children more skillfully than could teachers to the "precise contingencies needed to build subtle discriminations". And yet, we must ask whether it has been given an adequate trial. Perhaps we should look also at the work of Bijou (1968, completed in 1962) with a matching to sample machine of a similar design before judging Skinner's claims too harshly.

(4) <u>The work of Bijou</u>.

Bijou's machine was essentially similar to Hively's and to the one mentioned by Holland (1960, 1962). Its specific mode of operation was as follows: The child, sitting in front of the machine, would experience the following sequences of events: The top panel would first be illuminated, showing a sample picture. If S. pressed the sample, the match pictures would become illuminated. If S. now responded correctly, a red light would flash on, chimes would sound and a new sample picture would appear. Were he incorrect, the bottom pictures would disappear and the child would have to press the sample again. If he were then correct in his response choice the machine would deliver the reinforcement but instead of advancing to the next slide in the programme would move back to the previous one.

Figure 2.6

The machine used by Bijou (1968). See text for description of its mode of operation.

This procedure would, therefore, reinforce all touch responses, differentially reinforce correct responses, and halt the child around a difficult slide, preventing him from moving ahead by haphazard responding. In these respects it aimed to control the S's performance more closely than did Hively's machines. It should, incidentally, be noted that in most of the programme frames the child had to respond from five response choices.

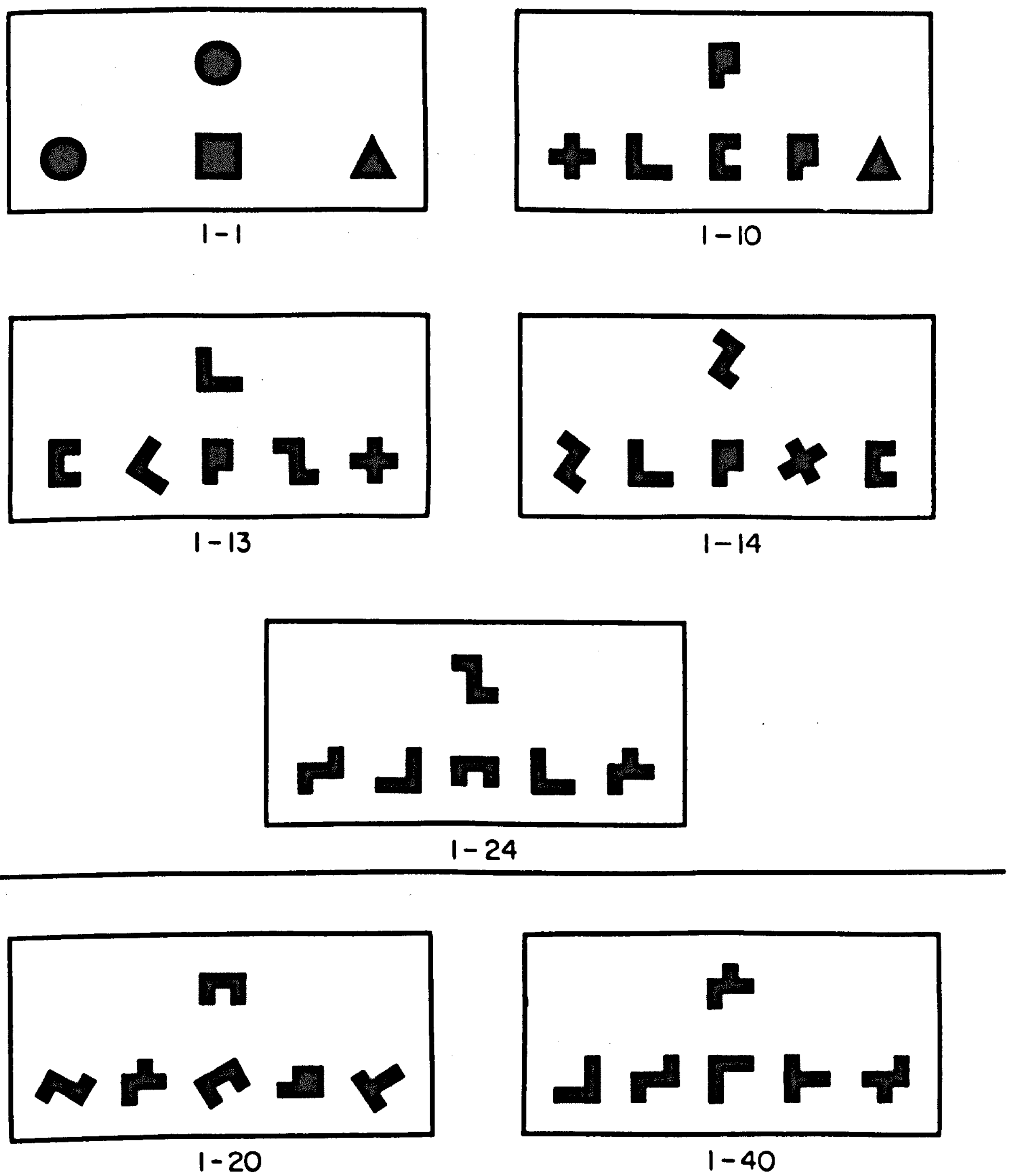
The subject in Bijou's experiments with this machine were 90 children whose ages ranged from 3 years 3 months to 6 years 11 months (89 retarded children took part in a later study, which will be described in Chapter 3). Children received introductory instructions in the use of the machine at the beginning of the experiment and were then left to work through the various slides of the teaching programme on their own.

This teaching material is the most important aspect of the study for Bijou; his aim was to study some aspects of the children's perception of the orientation of visual forms - as he called it - their possession of 'left-right' concepts:

> "The aim of the research described here was to explore what is involved in constructing an experimental history which would enable a child to discriminate geometric forms differing in left-right orientation. More specifically, the question was: What materials and procedures must be developed so that a retarded child can demonstrate a left-right concept, or can make orientational discriminations on nonverbal material?" (1968, p.66)

The 90 children were used in small groups to develop and evaluate the programme of discrimination training slides. Bijou gives no details of the development stages of the research but only of the final testing of the programme with 6 normal children and of its later development with retarded children. Let us now look at the programme Bijou developed with normal children. It consisted of 270 programme slides, divided into 'elementary', 'intermediate', and 'advanced' sets.

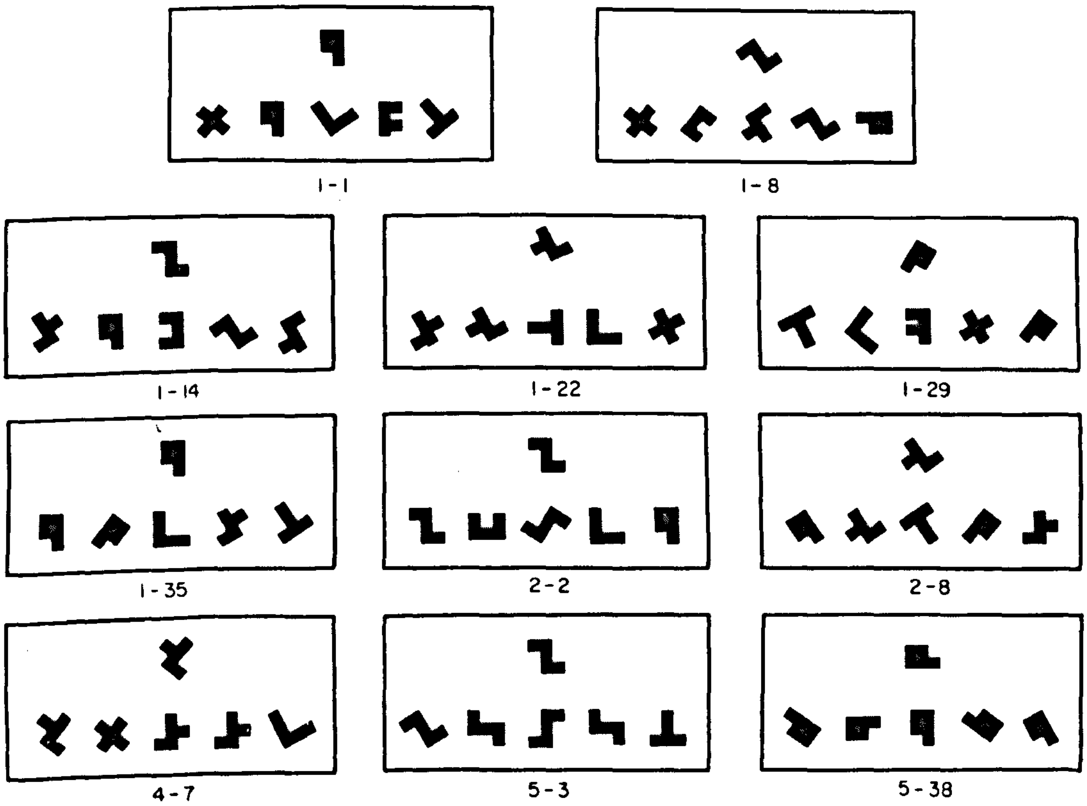
The "elementary" set consisted of a number of slides designed to ease the child into the operation of the apparatus. A typical slide is shown in Figure 2.7 as slide 1-1. By slide 1-10, the child would be matching from 5 response choices and the difficulty



<u>Figure 2.7</u>

Slides from the 'elementary' (above hoizontal line) and the 'intermediate' (below horizontal line) sets of Bijou's (1968) programme for the training of 'left-right' discriminations. See text for explanation.

continued/



<u>Figure 2.7 (continued).</u>

Slides from the 'advanced' set of Bijou's (1968) programme. See text for description.

of the discrimination required would be increasing. The series continues to 24 slides, when the child would be responding to pictures which contained a 90 degree discrepancy in rotation between the match and the sample.

In the "intermediate" set of 40 slides, rotational discrepancies between the match and the sample varied by as much as 180 degrees. The middle and last slides of this series are shown below the horizontal line in this illustration from Bijou's paper.

The "advanced" set comprised 206 slides, designed to train children to make discriminations between mirror images and nonmirror images of three forms presented with rotations in the vertical plane. As the illustrations of the slides from this programme show, the fineness of the discrimination required of the children increased markedly over the series. Bijou mentions that this increase was purposively gradual - he said that he had found 'fading'[1] valuable and therefore employed it as a guiding principle in the arrangement and design of the programme slides. Hively did, of course, use an essentially similar principle.

Bijou's evaluation of the effectiveness of this training programme was made with six normal children, before he began to study its use with retarded children. Testing the children with a representative selection of slides from the training programme before and after working through it he found that children made errors on about half of the slides in the Pre-test and on about 15% of slides in the Post-test. Thus, Bijou concluded, the training sequence was effective in training children to make these discriminations. Moreover, the training seemed to generalize to figures other than the ones in the programme: a set of novel forms was included in the post-test to measure generalization.

Discussion of Bijou's work

Bijou's paper reflects a different emphasis than Hively's

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(1) Terrace (1963a,b) had shown the value of gradually changing selected properties of discriminative stimuli in the direction of the nature of the final discrimination required to be made by pigeons in an operant task. The pigeons acquired the discriminations more rapidly than they would have done under conditions of 'differential reinforcement'; hence 'fading' proved to be a superior teaching method than more classical operant procedures.

in the use of teaching machines with young children. Hively had apparently intended to use his machine to study concept formation in young children, but was prevented from this by the difficulty his subjects seemed to have in matching to sample. His research was therefore predominantly concerned with studying the problems the children had in this and with a way in which the difficulty might be overcome. Bijou, on the other hand, had no such problem. His subjects seemed to acquire the matching principle quickly and were thus ready to receive the more difficult slides Bijou was using as his testing and training medium. It is certainly interesting to ask why two apparently similar groups of children appear to have such discrepant matching to sample ability. For an answer, we shall turn to our next study in this section, which was based on both the studies of Hively and Bijou. It was carried out by Fellows (1965) and forms part of his doctoral thesis.

(5) The work of Fellows

Fellows' work is valuable as a piece of original work in its own right, but it is more valuable as a piece of work which draws together the rather paradoxical work of Bijou and Hively and which adds to these almost exclusively Skinnerian studies some of the vast range of research conducted in the traditional framework of discrimination learning and in the field of the perception of orientation in visual figures by children which is relevant to Hively's and to Bijou's work.

Fellows' research has, as its rationale, that the use of teaching machines has much to offer the experimental psychologist as a means of conducting research which would otherwise be difficult. Interested in the perception of orientation in children, he saw in a machine like Hively's a way of testing children's perception of orientation reliably and accurately. And he was interested, too, in the discrimination process itself: matching to sample was a complex task, he believed, for young children. To watch them working at matching problems would be interesting and important in itself:

> "It was thought that not only would matching provide an effective procedure for manipulating the stimuli, and so enable many more actual discriminations to be tested per trial than either the classical approach-

avoidance discrimination learning procedure, or the discrimination learning-set procedure .... would allow; but also it should provide an interesting skill in itself, on which to perform a functional analysis." (1965, p.6)

Fellows' preliminary reading showed him that matching was 'cognitively quite a complex task and one which a young child (4-5 years of age) cannot consistently cope with." (1968, p.10) Nevertheless, he saw no reason why the children in Hively's sample for his second experiment should have any difficulty, especially when they were, in fact, much older than this (5 years 8 months to 6 years 10 months). He explains (1968, p.74) what he believes is the reason.

"If we look closely at Hively's procedure the explanation is clear. The fault lay in the incomplete and misleading nature of his initial instructions to the subjects. Not only did they fail to mention the discriminative stimuli or the need for matching, but they actively drew the child's attention to the response features of the task. As far as the child was concerned the game was merely to press the windows and make the lights change. One feels the training procedure might have been more successful had nothing been said."

Fellows confirmed this suspicion concerning Hively's instructions in a brief experiment with a similar machine and 2 groups of 10 normal 5 year old children. One group, receiving Hively's instructions did not learn to match to sample under conditions of differential reinforcement of correct responses. The other group, receiving Fellows' verbal instructions learned to match to sample in 26 slides.

These instructions, used in the majority of Fellows' experiments involved telling the child to 'look at the upstairs window', then to 'look at the downstairs window' and to 'find the two patterns which are exactly the same'. The game, the child was told, was to 'find the right pattern and make the window light up every time' (the feedback in Fellows' machine). Each child was given two demonstration items and allowed eight practice items, in which verbal praise was given for correct responses and slight verbal admonishment for incorrect responses. This procedure was then repeated as necessary until the child scored 9 out of 10 correct responses. Thus we can see that the difficulty children had in learning to match in Hively's experiments was probably due to the instructions they received at the beginning of the experiment. It would seem necessary that the instructions must be aimed at drawing the child's attention to the essential features of the task if they are to teach successfully and it appears that Hively's failed to do this. We can therefore surmise why Bijou was more successful. Not only were his instructions geared to the nature of the task: "Put your finger on this (sample in upper window) and press it. Find one here (choices in lower window) just like it, and press it. Good." (Bijou, 1968, p.69) but the instructions were repeated until the child responded to three consecutive slides correctly. In addition, the machine operated in such a way as to continually draw the child's attention to the need to look at the top panel before responding.

Unfortunately, however, things are not so simple as they might seem. One other vitally important factor in the acquisition of the skill of correct matching to sample by the child would seem to be the child's developmental age, using the term loosely. Two things point to the value of considering this factor. Firstly, Hively's first machine used a 'split' form of operation, as did that of Bijou, and yet children found difficulty in learning to match to sample (Hively also used instructions similar to those of Bijou, and his sequence of matching problems were of 'faded' format). Secondly, when Fellows' attempted to teach matching to younger children than those of five years of age, he found the instruction sequence unsuccessful (1965, p.385; 1968, p.81) and concluded that below a Mental Age (Chronological Age in these normal children) of about 4 years 6 months matching was difficult for the child to master, ascribing this to these children having a poor facility in the use of linguistic mediators, as well as to such children's tendency for 'impulsive' responding in tasks.

The remainder of Fellows' experiments were concerned with testing the perception of orientation in children by means of the matching to sample task. In practice, this meant teaching children to match to sample with simple figures and then noting the kinds of orientations which caused children to make errors in matching. Fellows verified that left - right reversed figures such as b-d were harder for children to discriminate than figures differing in any other kind of orientation, and devised a means of training children to perceive orientations, which although it met with some success, did not yet seem to be helping the children to match in terms of orientation more successfully. Interestingly, this method was unlike the training method of Bijou who used his machine and an appropriate programme of slides to train children to respond to figures which differed in terms of orientation. Fellows regarded this method as time consuming and requiring somewhat different apparatus. He used instead a modification of the machine he used to test the children's perception of orientation - but notes that he has had some difficulty inserting the device (which was intended to encourage the child to observe the nature of the difference between the stimulus figures) into the sequence of events needed to operate the machine without causing a severe interruption.

(6) Staats' operant approach to the teaching of reading

Staats' aim, over a number of years of research, has been to develop a detailed understanding of the role of learning in the acquisition of complex human skills such as reading, writing and arithmetic. To this end he has applied the principles of operant conditioning (and of classical conditioning and the results of studies with different 'theoretical' orientations, where these were relevant to the learning of these skills) developing, from this detailed S-R analysis, what he hoped were more effective teaching methods for them.

One of his most recent expositions of his ideas and work (Staats, 1968) shows that, in addition to increased understanding of these skills resulting from his theoretical analyses, there have been two main outcomes of his work which have immediate practical implications. These are the use of a matching to sample teaching machine as a means of more effectively studying reading as a complex skill and of teaching it, and the training of relatively untrained personnel in a variety of teaching methods based on Staats' analyses of reading, writing and arithmetic. The latter had arisen from the successes Staats had obtained with his daughter Jennifer before she started school. He believed that his application of 'learning principles' had accelerated her educational development and wished to extend this to other children. To do this required, however, more staff. He therefore trained more staff in his methods calling them 'therapy or instructional technicians'

(1968, p.323); these worked, in one study, with culturally deprived, pre-school children with apparent success. The implications for Staats were that such methods might fruitfully be taught to parents or to other relatively untrained persons, so that pre-school, or handicapped, children in general might be helped.

These studies with Jennifer and with other pre-school children did not exclusively employ particular methods or pieces of apparatus; rather they took a free approach to the actual teaching derived from the principles of Staats' theory. In contrast, the research which preceded and laid foundations for these studies had a much narrower orientation. This research was Staats' use of a matching to sample machine as a means of studying the acquisition of reading skills in the child.

Staats' teaching machine studies - and even his whole research programme - may be seen as having their roots in the thoughts which led to a paper on the relationship of speech development to the learning of reading (Staats and Staats, 1962). This paper, inspired by Skinner's (1957) S-R analyses of language, suggested that reading and speech are analogous processes in terms of what must be learned by the child. But, they suggested, speech in practice is 'taught' more efficiently than reading - the difference between the two being in the poor use of reinforcement in the latter:

> "We considered the acquisition of reading to involve getting the child to emit an appropriate vocal response while looking at a particular verbal symbol and then reinforcing the response. This training should establish the verbal symbol as a discriminative stimulus that controls the vocal respponse.
>
> .... we compared the way speech is acquired to the way a reading repertoire is established. We concluded that reading training is not as effective. The usual training, unlike what would be recommended from a learning theory view point, is relatively intensive and involves poor conditions of reinforcement... as a first step, a learning analysis suggested that there are aspects of training that might be facilitated by a better understanding of reinforcement within the context of reading acquisition." (Staats, 1965 p.31)

The immediate result of this was a series of experimental studies consisting of: a preliminary demonstration of the value of such extrinsic reinforcement as toys or sweets in facilitating the learning of a sight vocabulary in four year old normal children (Staats et al., 1962), a more fully controlled experimental set-up for studying such behaviours, comprising a matching to sample teaching machine, token reinforcement system, and recording apparatus (Staats, 1964),(see Figure 2-8), preliminary testing of this (Staats, Minke, Finley, Wolf and Brooks, 1964) and a fuller evaluation of reinforcement variables (Staats, Finley, Minke and Wolf, 1964).

The outcome of these studies was a firm belief in the value of reinforcement in the teaching of reading discriminations and of the value of the matching to sample teaching machine and ancillary apparatus as a way of studying such processes in a controlled laboratory setting. They had demonstrated that young children of pre-school age would, if reinforcement were provided, maintain a high rate of correct responding on the machine. Responding would be more frequent on an intermittent schedule (Variable Ratio, or mixed Variable Ratio-Variable Interval) than under continuous reinforcement (CRF) and more frequent under CRF than under no reinforcement. Children responded well to the token reinforcement system, by which tokens delivered by the machine could be exchanged for chosen toys, on a ratio basis. The overall system had maintained two children's interest over 40 daily 20 minute sessions. Having thus shown the workability of the overall procedure and having seen some of the important variables in maintaining children's discrimination behaviour in it Staats was ready to extend the system's application to other children. As a start, he chose six mentally retarded children; details of the results obtained with them will be given in a later section of the present work.

Little has so far been said either about Staats' actual machine, or about the programme materials he devised for it. As it is important to know something about both of these, we shall consider them briefly before proceeding to discuss Staats' work.

Staats' teaching machine consisted, as can be seen in Figure 2.8, of a matching to sample stimulus presentation unit, a token reward dispenser to the child's right, a Universal Feeder which delivered trinkets and sweets in exchange for the insertion of one token to the

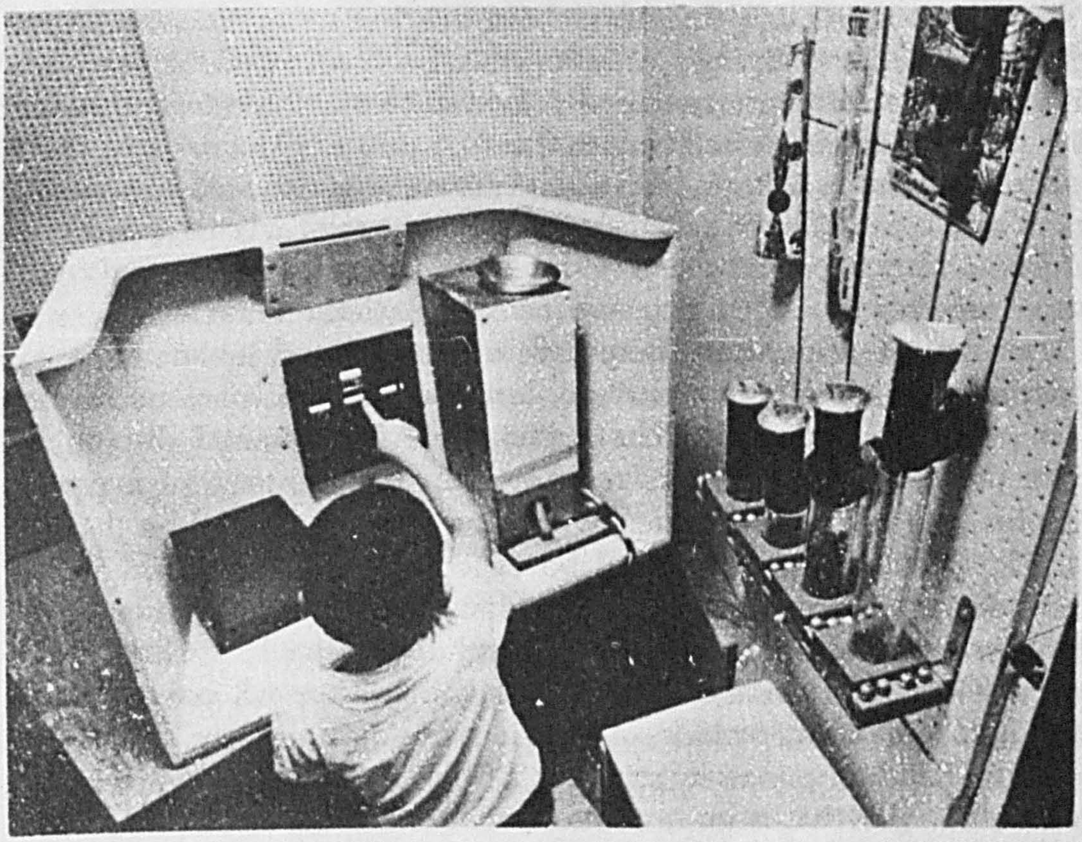

Figure 2.8

The experimental set-up used by Staats in various studies (see text). The child is responding to the stimulus display unit. On his right is a device which will deliver a marble after a correct response sequence has been made. Marbles may be 'spent' either for the toys on the child's right or in the funnel. A marble deposited in the funnel will lead to trinkets of sweets being deposited in the container on the child's left.

child's left, and a selection of toys on the child's far right which could be exchanged for different numbers of tokens. In front of the child was a doorbell-type push-button.

The aim of the machine and its ancillary apparatus was to present a reading task to the child, to which he would pay attention, and to maintain his interest in such tasks over a long period of time. This is seen by Staats as predominantly a problem of précise and powerful reinforcement; whether the child ultimately learns to read or not is initially immaterial - if the machine and the reinforcement contingencies it presents can control and maintain 'unit' reading responses better teaching of reading can later be effected by improved programme design.

The basic definition of a correct response in each of the reading tasks the machine presented was that S. said the name of a reading character while looking at it. This requirement was fulfilled if ever a stimulus was presented and S. 'read' its name aloud within ten seconds. Normally, however, S. would not know the name of the reading character so that the requirement had to be achieved another way. S's first response in each reading task was to press the push button. This illuminated a sample stimulus and three response choices, one of which was identical to the sample. S. could then read the sample stimulus, for which he would be immediately reinforced. If, in 10 seconds he had not done so, E. (who was out of sight) read the name of the sample aloud. S. was then required to echo this name, press the top, sample stimulus, repeat the name, find the matching character and press it and then to press the button below this. Reinforcement would then be presented according to the reinforcement schedule in force at the time. If an incorrect response occurred at any point in the response chain, a buzzer was rung and E again read the character S. would then have to repeat the whole chain.

Staats offers little description of his <u>programme materials</u> in his early descriptions of his teaching machine and notes merely that he used letters and 'letter-pairs' as reading 'units'. In 1968 he discusses them more fully, but even then devotes more space to theoretical analyses of the skills involved in reading than to the results of his practical studies.

He suggests that while reading is a complex process, in the early stages of its acquisition a principle task to be mastered is that of discriminating between letters and groups of letters in a variety of contexts:

> "Many investigators concerned with reading have pointed out that in the English language the same letter stimuli must often come to control different speech sounds when the letters are in different contexts. The letter 'a' is responded to variously, as in 'father', 'fate', 'fat', and so on. One stimulus must thus come to elicit several responses depending upon the context in which it occurs. This represents a complex type of learning." (1968, p.220)

To overcome this Staats suggests the use of diacritical marks in conjunction with letters. Thus an 'a' would be intended to elicit the 'a' sound of 'father', whereas an '$\overset{+}{a}$' could be intended to elicit the 'a' sound of 'fate'. Learning to read, in the early stages, would then be a process of the child learning to give the appropriate name for a variety of these symbols - and this could be done, Staats believed, with good experimental control by the apparatus already described.

Unfortunately, Staats does not describe much work in which the system is evaluated(1). His most detailed description occurs with his account of the responses of retarded children to the teaching machine apparatus but this is used primarily as an illustration of the methods by which the children were taught to discriminate between these quite difficult stimuli rather than of its effectiveness as a method of teaching reading.

Discussion

Staats has shown that young pre-school normal children will discriminate a variety of 'reading' stimuli (mostly letters and letter-pairs) presented on a teaching machine, demonstrating their ability either by naming the stimulus, or by responding correctly to it in a matching to sample task. They are sensitive to the reinforcement schedule

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(1) Recently, Johnson et al. (1972) modified parts of books by the addition of diacritical marks to indicate letter sounds. Children using these books in the first stages of learning to read proved to be superior to children using traditional orthography (t.o.) in sight reading not only in their own medium but also in t.o., and to be superior in spelling and in free composition.

offered by the machine, responding less often when no reinforcement is given or when it is continuous, than when it is intermittent. The token reinforcement system seemed attractive to the children and in at least two of them has maintained interest and correct behaviour over 40 experimental sessions.

Staats stands apart from the investigators so far described in that his main concern in the studies described has been for the effectiveness of the reinforcement provided in controlling and maintaining the subjects' behaviour. Although Bijou and Hively paid attention to reinforcement variables in their studies it was of less experimental interest to them than was the arrangement of their teaching programmes. In this respect Staats work is a valuable adjunct to the work described earlier in the chapter, since it has implications for the extent to which such machines may be used over long periods of time with young children, in the presentation of material which does not have great variety.

One other point of interest in Staats' work, which we shall discuss more fully in a later chapter, is the value he ascribed to the role of instrumental discrimination training by a matching to sample machine. Although Skinner and Holland, as we have seen, have suggested the importance of this kind of training they have not provided such a detailed rationale on its behalf as has Staats in relation to the training of reading as well as, Staats hoped, to arithmetic and writing. Unfortunately, Staats has not yet shown the ultimate value of such an approach to the teaching of these complex skills.

(7) Discussion and conclusion of Chapter 2

We have discussed four pieces of research which have involved young normal children working on matching to sample machines, briefly describing the aims of each, looking at what was done and examining their conclusions. Let us briefly remind ourselves about the details of each.

Hively used two teaching machines, setting out with the intention of developing them into techniques for teaching young children in a variety of tasks. He experienced difficulty with both machines in that children had difficulty in learning to match to sample on them and therefore devoted a main part of his research to developing a series of slides of gradually increasing difficulty to teach children to match to sample, which seemed effective for most children. Even so, some children managed to develop incorrect, systematic patterns of response which Hively attributed to their particular history of meeting similar problems. Thus, a main lesson to be learned from Hively's studies, is that unless particular attention is paid to the teaching of matching to sample behaviour in normal children with mental ages around 6 years and younger, few children are likely to acquire the skill in the short term and may develop incorrect patterns of responding. It would seem, therefore, to be a cognitively complex skill for such children, although not necessarily an impossible one.

Bijou apparently had no such problem as did Hively in getting children to match to sample and concentrated upon the problems involved in teaching children to discriminate among identical forms in different orientations. Like Hively, Bijou graded the problems in order of increasing difficulty, working empirically on the basis of errors made by similar groups of children, until he had succeeded in teaching them to discriminate between mirror and non-mirror images of three forms presented with rotations in the vertical plane.

These positive results led Bijou to believe in the value of this type of approach in the teaching of young children and considered that such an approach might well be adopted for other subject matters and for other children - such as those, like the mentally retarded, who had especial difficulty in learning.

Fellows' work showed us that Hively's second piece of work had initially ignored the need to bring children's attention to the essential features of the matching task, reminding us of its complexity for young children. Bijou had apparently had no difficulty in getting children to match to sample, probably because his instructions and machine emphasized the task's fundamental requirements. Fellows offered an alternative way of instructing young children in matching to sample by using a sequence of verbal instructions (although even this sequence failed to establish matching in children with M.A.'s below about $4\frac{1}{2}$ years) and went on to test children's abilities to discriminate between differently orientated forms by a matching to sample machine. Unlike Bijou, Fellows did not use this machine to teach children to make these discriminations, preferring a radically different machine designed primarily to teach children to observe differently oriented stimuli because of the difficulty and time involved in developing an appropriate set of programme slides - a potentially important consideration in terms of the wider educational use of matching to sample teaching machines of the kind so far described.

Staats did not mention any of these investigators in the works of his described here and did not seem to have been influenced by them. His major consideration was for the role of reinforcement in maintaining and controlling children's responses to reading stimuli and his work suggested that children would respond to appropriate reinforcement conditions by responding to intrinsically uninteresting stimuli over a number of sessions. This is not, however, to suggest that the use of reinforcement by the other authors described is inferior to that of Staats - although it is noteworthy that Bijou noted (1968, p.84): "The normal children were reluctant to come to the laboratory for repeated sessions." Staats' work does, therefore, suggest a way of maintaining children's behaviour should their interest flag. In common with the other workers Staats paid attention to the components of the skills required by the overall task and sought to achieve experimental control of them. He paid relatively little attention to the evaluation of programme materials for the machine but his theoretical considerations of possible methods of teaching reading by the machine has opened the way for such fuller work.

Taking the four studies together it is possible to draw conclusions about the responses of young normal children to such matching to sample machines as we have discussed in this Chapter, in terms of the information needed for our Analysis of such machines as noted in Chapter 1. It will be remembered that the five points of information required were: (1) the availability of machines appropriate to fulfilling Skinner's aims for a teaching machine for young normal or subnormal children; (2) that children would find such a machine attractive to use; (3) that they possessed the skills required to operate it; (4) that teachers would be able to use such a machine in their classrooms and (5) that sufficient programme material would be avilable for it. As a preliminary to our main consideration - that of the use of such machines with S.S.N. children - we shall consider how far these conditions apply to studies with normal children described in this Chapter.

Point 1 : Each of the machines described in the present chapter potentially may be used as Skinner believed necessary for successful teaching; it has been apparent that the authors of the four studies discussed above have been influenced directly by the 'Skinnerian' approach to instruction.

Point 2 : It is not easy to comment upon the extent to which children found the various machines attractive to use. Staats' planned use of reinforcement seemed to be an effective way of maintaining children's interest over a number of sessions, and this may indeed be a necessary feature of a machine when repeated sessions are envisaged. Certainly, children lost interest in Bijou's machine, which gave only lights and chimes as reinforcement, for he notes that children were reluctant to come to the laboratory to undergo repeated sessions. It is difficult to make precise comparisons between the studies of Bijou and Staats in this respect, owing to lack of data; Staats does, however, report the maintenance of behaviour over 40, twenty-minute sessions in two children and over more than 1,000 responses in seven children (Staats et al., 1964), in comparison to the 270 slides of Bijou's training programme.

No such difficulty has been reported by Hively or Fellows; in both groups of studies no mention is made of children refusing to work with their machines. Hively (1960) notes specifically that 25 of 27 children returned to the machine for as many sessions as were offered, which for approximately half the children was 120 slides and for the other half 240 slides. Moreover, he reports that the machine seemed to compete well with other school activities over the period of time children worked with it (what this was Hively does not say but a vague approximation may be obtained from his remark that children took between 4 and 13 minutes to work through a set of 40 cards).

Why Bijou should have had difficulty in maintaining the interest of children is difficult to say, but it is noteworthy that his task was difficult, requiring children continually to pay attention and to respond correctly, whereas those of Hively contained no such sanctions against incorrect responses.

Point 3 : Children have had difficulty in the execution of the matching to sample task required by the teaching machines in this Chapter, even when easily discriminable forms have been used as matching stimuli. It would, however, seem that this difficulty is a surmountable one for some children if care is taken in introducing the task to them. Thus matching improved under Hively's fading programme, under Fellows' verbal instructions, and seemed good under the combination of verbal instructions and the 'split' operation of Staats' and Bijou's machine. The importance of the factor of Mental Age in the execution of correct matching has, however, been apparent. Thus a 'faded' sequence of slides, in conjunction with a 'split' mode of machine operation in Hively's first study led to few children matching to sample and Fellows' sequence of verbal instructions similarly was less effective, with children of lower mental age. Children not learning to match to sample have developed patterns of incorrect responding which may be encouraged, it has appeared, by 'accidental' contingencies of reinforcement arising from the operation of the machine. With respect to these, no detailed discussion of their origins has been made with the exception of Hively who attributed them (1960) solely, it seemed, to the operation of the machine and (1962) to the additional factor of the child's previous history of 'attending' to different stimulus dimensions. Fellows, it may be noted, devoted time to considering these patterns of responding but principally with a view to using them to measure breakdown in discrimination performance rather than with a view to understanding them, *per se*.

Point 4 : Each of the studies makes no m ention of how their teaching machines may be used in the wider educational setting. This has not been forgotten, for all the authors have mentioned that they believe their machines to have wider potential. In this desert of commentary, however, is one small oasis; Hively notes in his first study that children seemed to respond well to his machine in an apparently busy classroom "in competition with other preschool activities". It should also be realised that this machine was small and self-contained; each of the others, with the exception of Hively's second machine which was also apparently portable, were machines requiring at least semi-permanent installation.

Point 5 : With regard to programme materials for these machines it is interesting to note the differences in emphasis between the various studies as they are presented to us.

For Hively and Staats understanding the machine and the parameters of its operation were the prime aims of initial experimental work, after which Staats, but not Hively, paid attention to what he might teach with it. For Bijou the machine was a potentially valuable way of improving children's abilities in a particular direction, for Fellows an experimental tool for investigating their abilities in, as it happened, the same direction (forgive the pun!) - that of the perception of differently oriented forms. Only Bijou really presented us with the knowledge that a matching to sample machine could be used to teach children something, although Staats implied that his machine could teach children to disciminate between and learn the names of various letters, and Hively showed that children could learn to match to sample on the machine. Thus, although there is some evidence, as Skinner believed was the case, that such machines can teach discriminations, no detailed attempt to show this has been made.

Young normal children, in conclusion, seem to have difficulty in the matching to sample task - which may be overcome by suitable machine design or instructions to the children. Even so, some children may develop incorrect patterns of responding on such machines, the reason for which may be either their previous history of such problems or cognitive immaturity or a mixture of the two. With appropriate attention to reinforcement variables, be this extrinsic, or possibly due to intrinsic interest of the machine and programme material, their attraction to the machine can be maintained over a number of sessions. Little is known about the problems of developing and testing programme material in variety for such machines but it seems possible that discrimination training can be effected by the machine and possible uses for this have been tried in terms of the skill of discriminating differently oriented forms and letters of the alphabet with, apparently, success for the latter and, definitely for the former. Little discussion has been made of the problems which might occur in the wider educational use of such machines even though it is thought that such machines and principles do have a bright future in this.

There is certainly little in the research so far to substantiate Skinner's claim (see p.19) that such machines as we have described have made "children .... far more skillful in dealing with their environments.. more productive in their work, more sensitive to art and music .. and so on". He had claimed that only machines were capable of building up discriminative behaviour, yet we have seen that children may have difficulty in using them, may not find them attractive, and have few programme materials with which to work.

CHAPTER 3 : STUDIES IN THE USE OF TEACHING MACHINES WITH S.S.N. CHILDREN

(1) Introduction

The aim of this Chapter is to continue the investigation of studies with machines similar to the Touch Tutor which was begun in the previous Chapter. Studies conducted with S.S.N. subjects will form the basis of the discussion but data obtained from studies with mildly subnormal children and with adult, brain-damaged ('aphasic') patients with matching to sample machines are relevant and will also be described.

(2) Extensions of Bijou's studies to mildly and severely subnormal children.

Bijou, as we have seen, developed and tested his teaching procedure on groups of young normal children. At the stage of his final evaluation he administered the programme to a group of 89 retarded children in a residential school (their chronological ages ranged from 6 years 4 months to 16 years 11 months; their mental ages from 3 years 10 months to 8 years 10 months; and their I.Q.'s from 32-66). The results he obtained with these children led to some revisions of the procedures, which were tested on further groups of children of similar abilities and age. There are thus two phases to this part of Bijou's study, and we shall consider them in turn.

At the end of the testing of the programme developed on normal children with these 89 retarded children it appeared that the programme was reasonably effective in teaching many of the retarded children left-right concepts. While, however, they did well for the most part on the "elementary" and "intermediate sets" (requiring discrimination of rotated forms) they encountered difficulties with the mirror-image discriminations required by the "advanced set" of slides. In general, children of lower mental age encountered more difficulty than children of higher mental age. Retarded children did similarly to the normal children in the "elementary" set, but measurably worse than the normals on the "intermediate" set, and therefore presumably on the "advanced" set.

It is not at all easy to learn from Bijou's account how children responded to the machine. His first table of results for example (p.77) lists, with no explanation, the results of only 8 children on the pre-tests and 10 on the post-tests. Whether the children are the same children in the pre- and post-tests and if they are where two extra children have come from, is not explained. We have no idea how representative these children are of the whole sample of 89; all that we know is that their M.A.'s range from 5 years in the pre-test to 7 years, and from 6 years to 9 years in the post-test. On the pre-test the group made, on average, errors on half of the slides. Taking the number of response alternatives as five, this gives, on the binomial expansion, a chance probability of .03. It thus seems, on this basis, that children were matching systematically, after their preliminary instructions (which were not of predetermined length; children were instructed, apparently, until they seemed to be matching well) on the difficult slides of the pre-test. This systematic matching continued into the slides of the elementary, intermediate and advanced sets for some of the children, but we are not clear again about this for some children were stopped before finishing the slides because they were making many errors. It seems from the tables given by Bijou that some children responded well to the instructions and programme, continuing to match many of the slides systematically. From this information, we cannot, however, form an opinion about the number of children for whom the task was initially difficult to acquire or in whom matching deteriorated markedly in the face of the increasingly difficult stimulus material to lead to completely chance performance. Our main source of information has to be Bijou's own impression of the reactions of children as revealed by the quote given below, and by the nature of his modifications (see below) to his procedures in Phase 2 of this study with retarded children. Judging from this, he thought that their matching behaviour was unsatisfactory. What we cannot do is a comparison in terms of the results of other studies we have investigated in order to be able to define the extent to which is was 'unsatisfactory'.

Bijou decided that the training sequence could be made more effective by a number of revisions aimed at improving, firstly, the power of the reinforcements delivered by the machine and, secondly, at improving the sequencing of the teaching materials. His rationale for the former involved a discussion of the effectiveness of the reinforcement contingencies of the machine; it provides important detail about the differences which may exist between normal and retarded children of similar mental age:

"It was essential that each S receiving training could demonstrate by his own performance that the contingencies being employed were functional for him. In other words, the light, the chime, and progress in the program following a correct response, had to have strengthening effects, and the representation of the previous slide, following an incorrect response, weakening effects. From nonsystematic observation, it seemed that the contingencies used were functional for the most part. The normal children were delighted with their correct matches and somewhat distressed about their incorrect matches. The retarded children also seemed pleased with their correct responses, but they were not overly concerned with their incorrect matches. Another observation deserves reporting: The normal children were reluctant to come to the laboratory for repeated sessions; the retarded children, on the other hand, were enthusiastic about coming and were eager to remain for long periods, although during the sessions they displayed considerable extraneous behaviors, e.g. nudging windows with the nose, fingering windows before responding, and making frequent unrelated comments. However, lacking systematic, objective data on the functional properties of the contingencies for individual S's, one cannot tell whether serious variations in a child's performance were the result of poor programming, ineffective reinforcers, or both." (op.cit. p.184; Bijou's emphasis)

With respect to the ordering of the stimulus material, Bijou decided to use only one stimulus form and to begin with simple mirror-image rotations in the programme, since it was with these that children had found most difficulty. Bijou thought that his training in non-mirror image rotated forms was contributing little to the intended terminal behavior of discriminating rotated mirror images; he gives little further explanation, however, of this modification.

Turning now to the second phase of Bijou's study, Bijou's first task was to alter the reinforcing properties of the machine in order to encourage the child to make a correct first choice to a new stimulus array. This involved strengthening the power of the reinforcement for correct first choices, eliminating the 'back up' procedure of the machine's going to the previous slide after an error had been made, and offering a milder reinforcement for correct responses after an error had already been made to that slide. The instructions of the Experimenter to the child were also made longer and more explicit. This procedure was as follows:

Seating the child at the machine, E. would point to the sample on the first slide, saying; "See this? Push on it and see what happens." If S. did so, the lower panels would be illuminated, revealing the choices. Pointing to the five choices, E. would say, "Find one like it here." (S. should point to the correct form) "Yes, push on it and see what happens." (If S. did so, light flickered, chime sounded, and bead rolled into a plastic box, visible to the child but unobtainable. The slide would back out, and the next sample appeared.) "That means you were right." Pointing to the sample, E. would repeat the instructions. If S. responded incorrectly during this instruction the directions would be repeated from the beginning.

On the fifth slide E., having pointed to the sample would say: "Let's find one that is <u>not</u> like this one and see what happens." If the subject made the intended incorrect match, the choice would be followed by a buzz and blackout of the choices. "That means you were <u>wrong</u>." Pointing again to the sample, E. would say 'Push on it again' (Choices appeared) "Find the <u>right</u> one this time. Go ahead." Having thus started the child on the programme, he would be allowed to continue working with the machine for 30 further slides. At the beginning of each subsequent session, the subject would continue to work with the machine until his performance on these slides contained fewer than two errors and the terminal points of the day's and the previous day's cumulative curve did not differ from each other by more than 5mm. from a point midway between them. At the end of each session the beads would be exchanged for toys and sweets on a ratio basis.

The objective of this pre-training procedure was mainly to accustom the child to the operation of the machine. It had also the further function of providing the experimenter with baseline data on the child's reaction to the machine and the stimuli. At the end of the procedure E. would know how attractive the child was finding the machine and its programme, how well he was matching to sample on the simple, introductory forms, and how stable his performance in terms of errors and response rate actually was. It was not an easy criterion to reach, however. 14 boys, with an average M.A. of 4 years 10 months (range 3 years 10 months to 6 years 3 months) took on average 8.5 sessions to reach the criterion of stable responding. The fastest S. reached the criterion in four sessions; the slowest in 17.

Bijou's description of the development of the procedure here breaks down. Pre-test - and Training-series of slides are described which aim to assess and train discriminative ability in the matching of mirror image discriminations and rotated mirror image discriminations. Three groups of five children were given various forms of training programme, but their error rate remained high throughout the programme. Bijou concluded that the procedure has been ineffective in teaching the left-right concepts to these children, but points out the insufficiency of data so far obtained. He offers little in the way of evaluation of the revised procedure, no comment on the effectiveness of the new machine design. In general, little detail is given by Bijou after his initial discussion of his procedure for this second phase of the study.

<u>Discussion of the extensions of Bijou's studies</u>

One important lesson to be learned from this extension of Bijou to his previous work with young normal children is that, although the average mental ages of the two groups of children - normal and retarded - are approximately equal extrapolations from results obtained with the former to the latter can be misleading. The difficulty which first presented itself to Bijou was that, even though the retarded children were keener than the normal children to come to the laboratory for repeated sessions, once they were there they were less influenced by the reinforcement contingencies the machine presented than were the normal children. Being less concerned about making wrong responses, they were less careful in their choices as the material became harder, and they learned less and less as the stimulus control exerted by the gradually sequenced programme material was progressively lost. Bijou notes that 'extraneous behaviours'(for example, nudging the machine panels with the nose) appeared, evidence that the machine had lost control over the children's behaviour in relation to it, or at least the control the experimenter intended. Bijou clearly made an attempt to increase this experimental control but seems to have given up the endeavour, leaving us in the air about the effectiveness of his modifications to the machine and procedure.

On the positive side, children seemed on the whole to respond well to the machine and seemed to be able to match to sample on it. Unfortunately, since Bijou offers little detailed description of the numbers of children who responded correctly to the machine in the various stages of his programme it is difficult to gain a precise picture of its value for them. Apparently, children of higher M.A. (around 7 years to 9 years) proceeded furthest in the programme, on the whole.

Bijou, as we might expect, gives little discussion of the future he sees in such techniques for the wider education of the subnormal. Reservedly, he sees his work merely as a jumping off point for later workers. In his conclusion to the paper, he points out that the 'In this study.. the method was stressed'. (op. cit.p.95) This method he used, he says, could be applicable to many problems:

> "Clearly, the availability of a workable laboratory method would open the way for empirical-functional study of theoretical and practical problems in this area .. Relative to theoretical issues, the method could be a vehicle for an experimental analysis of Piaget-type concepts ... and classical Gestalt problems, including perceptual constancy and figure-ground relationships.. With respect to practical problems, such a laboratory-type method could provide a functional framework for the diagnosis and treatment of learning disabilities such as reading retardation, aphasia, and articulatory difficulties .. for each of these the prescription for accomplishing the task of building or rebuilding behavioral repertoires would be described in empirical terms (accounts of procedures and materials), not in hypothetical terms, neurological or otherwise." (ibid.)

We are thus being left only with the possibility of such a machine being valuable for the mildly and severely subnormal. Little more than this possibility is here, however, being given.

(3) Staats' extensions to mildly and severely subnormal children

Staats reports studies extending his work with young normal children to six retarded children with I.Q.'s between 67 and 32 and M.A.'s between 6 years 5 months and 3 years 2 months. His aim in doing this was to discover, by detailed laboratory study of their learning, whether their retardation could be ascribed principally to intrinsic 'defect' or merely to 'unfortunate environmental (training) circumstances'. (1968, p.240)

His general plan was to administer the various programme materials developed earlier with normal children to the retarded children, noting points at which responding slowed down or became incorrect. At such points he would make additional slides, or adopt additional instructions so as to overcome the difficulty the child was experiencing.

The results obtained with this procedure suggested one major difference between these retarded children and the normal children with whom he had worked previously. Whereas it had been possible to introduce the various sections of the programmes (i.e. where the nature of the task changed qualitatively) with a liberal use of verbal instructions it was markedly more difficult with the retarded children. This was particularly so in the training of the sequence of operations required to operate the machine (see page 32 above) where normal children had required only two sessions to learn the chain of operations but where the two children with the highest M.A.'s and I.Q.'s had required five sessions and the other children more. Additionally, where, previously, verbal instructions had principally been used now increasingly non-verbal methods were necessary, particularly for the children with lower I.Q.'s and M.A.'s.

Despite these difficulties, Staats succeeded in getting all six children to the same stage of discriminative performance as that reached by the normal children. The child most difficult to train needed 30 sessions of training with the machine in order to achieve this level of performance, with the others taking fewer trials (no figures are given of these for the other children). This finding led him to a predictable comment - that "rather than thinking that there are personal qualities of intelligence, or ability, talent, and the like, it is suggested that individuals have varying degrees of behavioral repertoires that will determine how successful they are in that particular task." (op.cit.,p.257).

Thus, he suggested, it is pointless to suggest that, for example, retardates have deficiencies in discrimination learning ability (he earlier had referred to the work of Zeaman and House (1963) in this respect, as workers, who had suggested this) when what they can be seen to lack is merely necessary prerequisite behaviours for the discrimination task. Once these are taught, as in this study, the child is seen to respond at a more competent level. The wider implication for Staats is that:

> "It is more important to conduct studies on how retardates learn the types of repertoires they actually need in life ... within the laboratory where it is possible to ensure that learning conditions are appropriate (for example, reinforcement conditions)... In this way we will be able to discover what retardates are actually capable of learning; the present findings suggest that it is greater than has been thought. .... Furthermore, such study should eventually culminate in findings which will allow us to devise methods of training retardates with which to bring the retardate to his maximal level of behavioural development." (op. cit., p.258)

Staats does not describe how this last aim may be achieved other than the general suggestion that it could be by extending this present approach.

Discussion

Staats study shows that good results can be obtained with mildly and severely subnormal children in the teaching of reading discriminations of a complex nature and it suggests the value of his machine and reinforcement system in creating and maintaining the attention to the task in hand in these children. On the other hand, it is worthwhile to remember that each child was given close individual attention by an experimenter as well as experience with the machine and it could well be argued that good results could be obtained without the machine if children could be given individual teachers. This however is a debateable point - at least the machine and the theoretical orientation give the teacher a systematic approach to the child's behaviour and its maintenance and change.

It is difficult to gain much precise information from Staats' work about the wider use of such a machine with S.S.N. children. What he has demonstrated is the feasibility of the medium as a teaching system, although this may depend on the close attention of individual experimenters(teachers) for each child. Like Bijou's work, the methodology is stressed in Staats' study and given an important role. We shall see the same in Sidman and Stoddard's work. All these workers are suggesting the value of an empirical approach to the education of the subnormal, for which operant procedures are especially valuable. They say less about what can be taught by such procedures, and less still about how they may be generally applied in the wider education of the subnormal.

(4) Morgan's applications of a matching to sample teaching machine in and E.S.N. school.

Morgan (1971) is the headmaster of a residential E.S.N. school in the north of England. On taking up the post he was struck by the environmental impoverishment of his children, seeing as a cause or correlate of their educational subnormality a failure to pay attention to important details of their surroundings. Education for them, as he saw it, had to help them notice their surroundings.

Also, he saw their difficulty in attending to spoken language. Thus a child listening to a description of a scene might fail to take in the details of the description and might accordingly fail to benefit from that chance of noticing details of that aspect of his surroundings.

Morgan's remedy for these joint deficiencies was a teaching machine of matching to sample design. Yet even though it employed this principle with which we have so far had considerable acquaintance it was unlike any of the machines we have discussed, or will discuss at any later point. The machine was both designed and constructed by Morgan himself.

The child sitting in front of the machine would see a large sample panel approximately 2 feet by 1 foot in size with three smaller lower panels below it. Pictures would be projected upon this screen area by a slide projector mounted some distance behind the panel to give the desired size of picture. After the picture had appeared a tape recorder would begin a description of the picture (for example

"On the picture you can see Mrs. Smith sitting behind the table with Mr. Smith standing beside the sink. Joe is playing with his sister under the table. Where is Joe's sister playing?"). The child then would have the opportunity of selecting one of the response panels in answer to the question. These would each contain an answer in some suitable form for the present abilities of the child (for example they might be written) one of which would be the correct one. If the child picked the correct one he would be rewarded by a Smartie which appeared in a transparent tube, at present unobtainable to him. If he were incorrect no Smartie would be given and some appropriate alternative contingency would occur - for example an alternative track of the tape recorder might repeat or explain the problem to the child. If a child were incorrect, however, all Smarties then gained by the child would be irretrievably lost into the maw of the machine. Morgan (1970) reported that this was an extremely effective deterrent - he could not get even one child to choose incorrectly to demonstrate this.

By this procedure Morgan appears to be making children pay attention to spoken description; the programme itself is so arranged that discriminations of various kinds are taught to the child. In addition, the discriminations are related to appropriate linguistic mediators - a valuable educational exercise.

Two other features of Morgan's work deserve mention. One is the fact that he promotes communication between different members of his teaching staff so that lessons on the teaching machine and other lessons, for example, visits outside the school are tied in with each other. The other is that he has made a wide range of programmes for the machine so that it is used at many points in the school curriculum. Both these are important because they reflect the fact that Morgan is aiming his machine at the everyday classroom teaching of the children in his school; unlike the previous investigators we have discussed. This is Morgan's prime aim for a teaching machine, not just in the long term, but in the short term.

Discussion

Morgan reflects, in the use of his matching to sample machine, a different emphasis to previous investigators. He has not tried to argue great claims for his machine or to explain the minutiae of his work with it. He is mainly concerned that the machine works in a school setting and that he can maximize its usefulness to the children. Particular differences between his machine and others we have described are in the extensive use of a verbal commentary, a larger response panel area, relatively infrequent changes of slide, and a reinforcement system involving an apparently powerful aversive consequence for incorrect responses. We have no data on which to judge the efficacy of the system and to compare it with the previous machines we have discussed, but it is possible that Morgan's use of these factors makes his system a considerable improvement on those so far discussed. Morgan did not like the Touch Tutor - for he apparently designed this system after seeing the Touch Tutor and disliking it.

Before leaving this account of work with E.S.N. children it should be noted that at least one other headmaster of such a school has been active in promoting the use of programmed instruction. This is Marshall who published (1969) an account of his ten years of work with simple multiple-choice machines in the teaching of reading. Marshall's work shows, as has Morgan's, the feasibility of incorporating teaching machines into the classroom routine of such children, and points to the necessity of a wide selection of teaching material for use with the machines.

It has been necessary to mention Morgan's work for it provides an upward extension of work with matching to sample machines into their use with the more mildly subnormal. However, it may not necessarily be the case that machines used with such pupils can be immediately used with the more severely subnormal so that care must be taken in the application of such studies to the problems of such children.

(5) <u>The work of Sidman and Stoddard</u>

Sidman and Stoddard (1966, 1967) conducted studies in the use of a teaching machine with young normal and S.S.N. children, following a similar pattern of study to that of previous workers such as Hively and Bijou. A principal difference between their studies and previous ones, however, was in their use of a machine which did not employ the principle of matching to sample, but that of 'oddity' responding. Their work is, however, relevant to our present discussion and is therefore included.

The initial problem Sidman and Stoddard set themselves was deliberately 'simple'. By using the methodology of operant conditioning and programmed instruction they wanted to ask severely retarded non-verbal children if they could distinguish a circle from an ellipse.

The development of a method to achieve this was similar to that of Bijou. A machine for the presentation of stimuli and the reinforcement and recording of the children's responses was designed, a teaching programme made and tried with several groups of children. On the basis of the results of each group of children the programme was modified with a view to preventing the children from making errors. Fading was used as the main principle of programme design, with the aim of leading the child smoothly from what he knew at present to what it was intended for him to know by the end of the teaching session.

Their teaching machine, shown in Figure 3.1, consisted of a matrix of nine plastic response panels. A slide projector behind them displayed the stimulus material on them. A correct response to the panels led to the sounding of door chimes, followed by the delivery of a Smartie or some kind of similar reward. Incorrect responses caused the pictures to stay on the screen until a correct response had been made, when the machine showed the previous slide.

The progression of a child through the teaching procedure can be represented as a series of aims. The child was first taught to retrieve a Smartie from the dispenser tray when the dispenser operated; next to learn that pressing the panel which was illuminated led to a Smartie. When the child was systematically pressing that panel which was lighted and none of the darkened panels on the machine the programme of teaching slides was begun.

A schematic illustration of different steps in the first part of the programme is given, in Figure 3.2. At 'A' the child was systematically pressing 'light + circle' and not 'dark' (such words representing the intended discriminative cues) At 'B' and 'C' the 'light' cue is being progressively removed ("faded out") until at 'D' the child is responding on the basis of 'circle vs. no circle', and the third aim is achieved.

The second part of the teaching programme followed an identical pattern, gradually fading in the ellipse form until, by the end of the sequence, the child was discriminating circle from ellipse.

Figure 3.1
A child responding to the teaching machine of Sidman and Stoddard (1966,1967). See text for explanation.

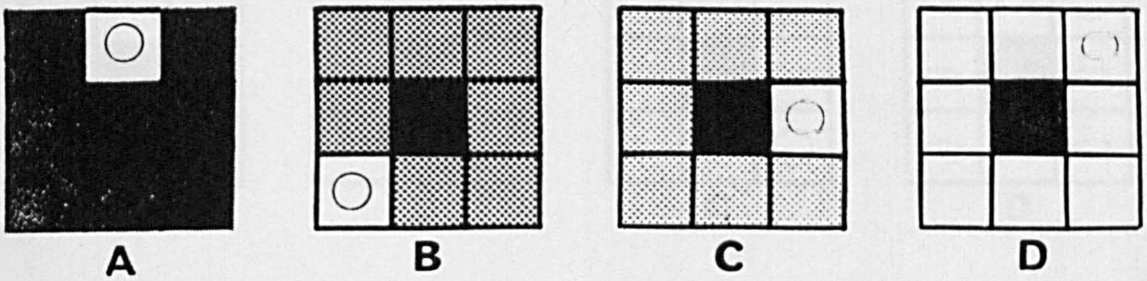

Figure 3.2

Spaced steps in the 'background fading' section of Sidman and Stoddard's circle-ellipse discrimination programme (1966). The brightness of the background illumination of the nine response panels increases gradually so that, from responding on the basis of two relevant cues (form + brightness) at the beginning of the programme the child is responding on the basis of only one (form) at the end of the programme.

continued/

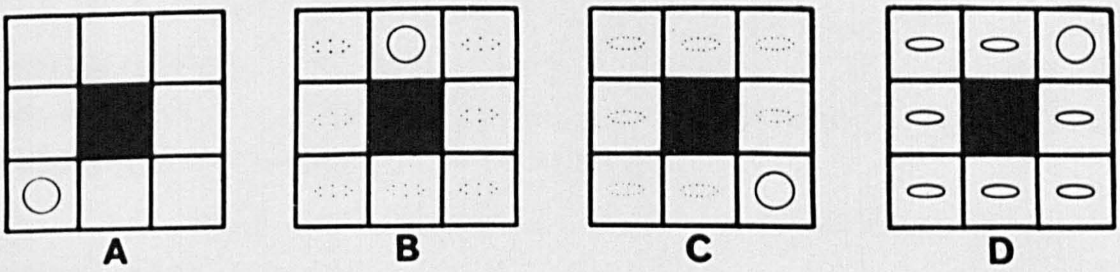

Figure 3.2 (continued).

Spaced steps in the 'ellipse fading' section of the programme. The brightness cue is progressively reduced in salience by the fading-in of the ellipses so that the child ends by discriminating the circle from the ellipses.

In the final version of this teaching programme there were only 18 slides in this sequence; this was tested with 30 children of whom few details were given apart from that 9 were younger than three years of age. Only one child failed to learn the discrimination out of this group consisting, apparently, predominantly of normal children. The various versions which preceded this final one (six in all) were tested on groups of retarded and young normal children, but few details of the overall composition of the groups are given.

Sidman and Stoddard were pleased with the results of these initial studies. They had succeeded in satisfying themselves that their use of operant conditioning and programmed instruction techniques was serviceable for use with nonverbal children.

Their next interest was to develop the principle of nonverbal communication by these means in order to achieve a more precise insight into children's sensory capacities, an insight they thought difficult to achieve in nonverbal children by conventional methods of assessment. Before describing this it will be valuable to offer the words of the authors themselves as a conclusion to the first stage of their work. This quote will have the dual purpose of giving the reader an insight into the authors' convincing and optimistic style as well as informing him more fully of the aims of their research. The quotation is lengthy but important.

> "We have shown that the program is an effective device for nonverbal communication. Without any other form of instructions we have communicated to our children that they are to choose circles and reject ellipses. The program can accomplish this task of communication in 5 minutes or less, with normal children as young as 2 to 3 years of age and with older retarded children. It does not matter that some of our children could talk or that some of them already knew the difference between circles and ellipses. Our ultimate interest is in preverbal or otherwise nonverbal children, with whom some other means of communication must be found if we are going to be able to evaluate their behavioural potential fairly. Because most of our standard intelligence tests, even the so-called 'nonverbal' tests, depend heavily on verbal

instructions, most children who cannot talk earn a low I.Q. We often doom these children to an institutionalized or otherwise impoverished existence simply because they do not speak our language.

The Philosophy behind our persistent efforts to develop the circle - ellipse program can no longer be regarded as an academic issue. It is a set of methods that work. We have found empirically that in order to teach effectively we must first prepare ourselves to learn from our children. Their errors are a lesson to us. They make mistakes because or teaching is inadequate. The proof was the progressive elimination of errors as we revised our teading program. With successive revisions the children made fewer and fewer errors, and more of them reached the point to which we were trying to get them.

Are these statements too sweeping? After all, we have only taught our children to tell circles from ellipses, a performance which will hardly play an important part in their lives. We certainly do not propose our program as a substitute for I.Q. tests. We believe, however, that the methodology is general. It can be applied to areas of much more immediate consequence to the children. We shall expand on this notion below.

Meanwhile, let us return to the problem we originally set ourselves. Teaching the children to discriminate circles from ellipses was only a preparation for a more precise evaluation of their visual perception. The sensory evaluation of children who cannot or do not talk is a vexing practical problem to neurologists as well as to teachers who want to know whether a child is capable of learning some of the things he is ordinarily expected to learn.

The circle-ellipse serves as a substitute for verbal instructions. It is our way of telling nonverbal children what to look for .... When they completed our program, the children were attending to the relevant stimulus dimensions just as well as children for whom

> verbal instructions are appropriate. We are now ready to determine how fine a discrimination they can make." (1966, pp.186-187).

Sidman and Stoddard go on to describe work with a programme of slides in which the ellipses progressively grew similar to the circle.. By this means they were able to locate a difference threshold for the children who went through this second sequence of slides. As a child made an error, the previous slide would again be presented and the child would have an opportunity to try again. If he did not progress then beyond this point they assumed he was not able to discriminate the circule from the ellipse.

Doubtful about the effects of the programme step-size in this sequence they added a number of intermediate steps between the main steps of the program. Children thus worked through a much more finely graded sequence of discrimination tests. Sidman and Stoddard had been concerned that in the former series they had not been teaching the child to make as fine a discrimination as he was able and they note:

> "The changes were made in the threshold series ... produced results that strongly support the necessity for careful programming even in a testing procedure. After we made these changes our whole set of age norms for the circle ellipse threshold had to be revised upwards." (op.cit.,p.195)

They see this is an important finding. 'Don't test, teach' they had said earlier in the paper (p.158) and here they were demonstrating the effect of neglecting the maxim:

> " the neglect has undoubtedly been responsible for the under evaluation of many children's sensory capacities as well as the abandonment of many children on the grounds that they could not be evaluated at all." (op.cit., p.195)

Clearly, they see the procedure as offering considerable educational hope for the subnormal and brain-damaged child. Their concluding remarks to this general account of their work ring brightly with optimism:

> "We have described the development of a nonverbal technique for teaching children to discriminate circles from ellipses, and a combined teaching and testing procedure, still nonverbal, for determining the quantitative limits of their ability to distinguish these forms. It is now possible for us to secure information about visual function in children who are otherwise unreachable. While our methods have been applied only to a single aspect of visual perception, there is no reason why they could not be extended also to visual functions such as acuity, brightness thresholds, flicker fusion etc. The techniques are potentially valuable not only for testing sensory capacities, but for teaching the children skills that are more relevant to their everyday necessities. It should be possible to use letters, numbers, words, colors, sounds, etc., and thereby lay the foundation for programming more advanced materials..." (op.cit., p.197)

This description portrays the main philosophy and contents of Sidman and Stoddard's work, as reported in their first paper in 1966. That general account contains considerable details of their research, and yet lacks much information about the use of the procedures with severely subnormal children. More precise knowledge of this can be gained from their technical report in 1967 which tests the efficacy of the circle-ellipse fading program in establishing the discrimination in a group of institutionalized subnormal children. Let us now turn to this.

19 retarded boys, whose Binet I.Q.'s or Vineland Social Quotients ranged from 18 – 39 were divided into two matched groups of subjects on the basis of staff member rankings, C.A.'s and I.Q. or S.Q. scores. Sidman and Stoddard's description of them was:

> "The six most advanced children could understand simple instructions, and three of them could use poorly articulated speech to make their simple needs known. Most of the children rarely, if ever, spoke, and gave little indication that they understood spoken language." (1967, p.4)

One group - the 'Program' Group were given the circle-ellipse fading programme of 17 slides, with the usual introductory instructions. The other group - the 'Test' group - were given a succession of slides which required them to make the same discriminations as the 'Program' group, but without the help of the progressive teaching programme. They were introduced to the procedure with the same instructions as the 'Program' group.

The results implied that the fading procedure was a more effective teaching method than was the procedure of merely supplying differential reinforcement for correct responses. Of 10 children in the 'Program' group 7 learned the discrimination, making from 1 to 25 errors in the process. In the 'Test' group, the results are slightly more complex. One child passed a first test of 10 slides (requiring the circle-ellipse discrimination with no prior fading programme) making 18 errors. 6, excluding him, passed a similar test of the form-no-form discrimination (7 slides) subsequently and two failed. Those who passed made 0,4,4,8,13 and 47 errors. Three of them then passed a second administration of the circle-ellipse test making 35, 35 and 58 errors. Subsequently, one child passed the ellipse-fading programme achieving the final discrimination in 43 errors and one child passed through the background-fading programme when this was given him, achieving the form - no-form discrimination in 6 errors but failing the circle-ellipse discrimination. In all of the 'Test' group, therefore, 5 passed the circle-ellipse discrimination making from 78 to 252 errors.

These results can be interpreted either as meaning that the 'Program' group recieved clearer instructions by the fading procedure as to what was required of them, or that it taught them to make a discrimination of which they might otherwise have been incapable of making. The former interpretation is consistent with the aims of the authors and is probably the more likely interpretation.

Before we leave the work of Sidman and Stoddard, it is essential to mention the appearance of what the authors call 'error patterns'. Earlier, they had noted, when running children through the circle-ellipse difference threshold experiment that "the positive and negative keys were actually becoming less discriminable as the child progressed, and the series was designed so that the child would eventually reach an ellipse he could no longer distinguish from the circle. When the child reached this point he found that his former criterion for choice no longer worked. It no longer sufficed to look for the circle or for whatever aspect of the forms he had been observing. All the stimuli had become 'circles'. Reasonably enough, he had changed his criterion. Two substitute criteria that we could easily see in the children's data were (a) to select the key which had been correct on the previous trial, and (b) to develop a fixed pattern of moving around the keys until the correct one." (1966, p.192).

The result of this was that errors seemed to create more errors - errors would frequently occur on slides to which the child had previously responded correctly, after an error caused the machine to present previous slides.

In the later series of studies errors again occurred and error patterns were again noticeable. This time Sidman and Stoddard adopted a similar attitude to their appearance, but emphasised here the importance of inadequate reinforcement contingencies in their causation, as much as the difficulty of the stimulus material. We shall go into this in detail later in this thesis, noting only for now Sidman and Stoddard's similar view to the early one of Hively - that response patterns are caused by inadequate reinforcement contingencies.

Discussion

One of the most interesting features of Sidman and Stoddard's work is the apparent ease with which children were trained in the use of the machine. We can attribute this, as the need for revisions in the first study, and the experimental testing of the second study, show to the carefully designed teaching programme. We might expect that if the same time were devoted to the design of the teaching of matching to sample, this skill might be taught more easily than has so far been the case. On the other hand, there is some evidence that the task which Sidman and Stoddard are requiring of their subjects is cognitively easier than matching to sample. Sidman and Stoddard's task is in fact requiring the child merely to look for the 'odd one out' of an array of 8 stimuli - an 'oddity responding' task, not to look first for the 'sample', then to search remaining stimuli, and to find the one which resembles it. Wodinsky and Bitterman (1953) and Ginsburg (1957) have shown that an 'oddity' task is slightly easier, at least for rats, than a matching to sample task. What is perhaps the case, therefore, is that this machine is requiring the subject to perform a simpler task than would a matching to sample machine and that this fact should be borne in mind when considering the implications of these studies for the use of a machine employing this principle.

The experimental manipulations of the second (1967) study show that S.S.N. children benefit from the carefully planned sequencing of programme materials of the kind used, and the study in general suggests that they find the machine and reinforcement system attractive. It is interesting that the S.S.N. children, however, did not all respond well to the programme, for some of them developed incorrect response habits and failed to learn the discrimination. In contrast, the normal children, who were apparently of similar mental age to the S.S.N. children, nearly all learned the discrimination. It is difficult to make precise comparisons between these two groups of children, owing to the lack of detail given about them, but these results do again suggest the dangers of making too many inferences about the responses of S.S.N. children on the basis of those of normal children to teaching machines.

These studies show a departure from those we have so far discussed not only in the use of a different kind of machine but also in the different kind of emphasis placed on the nature of programme material for the machine. Sidman and Stoddard's aims were largely to develop a means of testing the abilities of nonverbal subjects, rather than to demonstrate kinds of teaching materials. Accordingly, they were not satisfied merely with having taught a discrimination, but wished to teach it more efficiently, as in the initial stages of the study, and to teach the finest discrimination they could, as in the subsequent developments of the initial study.

Even so, they make some reference to the use of their methods in teaching, suggesting the possible extension of their circle - ellipse programme into the teaching of letter- and number - discriminations. Unfortunately, like other workers they do not consider detailed problems such an application might pose, leaving only the 'promise' of their work:

> "The success, with retarded children, of a teaching method that reduced errors ... should not be interpreted as meaning that retarded children are simply the products of inadequate instruction. A more valid inference is that

their capabilities have been underestimated. More effective instructional procedures than those in general use are available to estimate the behavioral potential in children limited to developmental or acquired abnormalities." (1967, pp.14-15).

(6) Studies using 'free-operant' techniques with the S.S.N.

It is doubtful whether the psychologist or teacher who saw himself as interested in the role of teaching machines in education and who thought about the methodology of the doctrine of 'programmed instruction' would feel himself to be on completely sure and familiar ground in the preceding discussions we have had of teaching machines relevant, potentially, to the needs of the S.S.N. These matching to sample machines do conform generally to the principles Skinner set out for the teaching machine but the studies which have used them have smacked of an adherence to the methodology of 'operant conditioning' which is unfamiliar win the 'teaching machine' literature. Bijou talks of 'baselines', Staats of 'schedules of reinforcement', and so on.

The main reason for this apparent difference between the previous workers with 'teaching machines' and most of the others lies mainly in the abilities of their subjects. It happens the methods and machines which are suitable for the largely non-reading S.S.N. child (or young normal child) relate more closely in methodology, if not in basic principles, to the 'operant conditioning' rather than to the 'programmed instruction' work. This is made even more pronounced as we begin to consider S.S.N. children who are increasingly cognitively immature. For some S.S.N. children it is likely that they do not possess even the skills required to operate the machines so far described. For these children, simpler machines operating on similar principles may be justified. So it is that a discussion of tasks involving the manipulation of levers for rewards is legitimate in this survey of teaching machines for the S.S.N. It will be valuable here, then, to describe briefly some operant studies with the S.S.N., concluding with the study of Friedlander et al. (1967) who describe operant apparatus which more nearly reminds us of a 'teaching machine'.

There are a number of studies which describe the use of lever-pulling or lever-pressing tasks with S.S.N. children and adults in American subnormality hospitals. Typically, subjects are required to operate the lever-manipulandum (or there may be more than one) in order to gain some kind of reward such as a sweet. Once the subject consistently operates the lever to gain the reinforcement the task is complicated - most commonly by either administering reinforcements infrequently on some schedule of reinforcement, or by administering reinforcements only for responses associated with the presence of some stimulus. For example, House et al. (1957); Ellis et al. (1960); Orlando and Bijou (1960); Bijou and Orlando (1961); and Headrick (1963b); studied the sensitivity of subjects to changes in reinforcement schedules; Orlando (1961), Barrett and Lindsley (1962), and Orlando and Bijou (op.cit.) examined the development of stimulus control in tasks where reinforcement could be obtained when, for example, a light of a certain colour was shining.

The general conclusions of these studies are, as has been noted in Chapter 1 of this volume, that S.S.N. subjects can work well in such settings with Smarties or exchangeable tokens as reinforcement, and are generally sensitive to the effects of different reinforcement schedules. So far, it has been difficult to show obvious uniformity between the various subjects studied in terms of response rates, pauses and so on, but some similarity between the results of studies with rats and those of these studies with subnormal patients has been found (for example, post-reinforcement rest - pauses giving rise to 'scallops' in the cumulative record have been obtained in the records of some subjects, though not in all). Subjects have also learned to respond only in the presence of a certain stimulus, or only to a certain manipulandum, showing discriminative ability in this kind of setting.

One general fault of these studies is the unsystematic sampling of the subjects, the comparatively short term nature of most of the studies, and a willingness to suggest the great potential value of such an approach without any discussion of the problems of gaining such value - but then these are faults of all the studies mentioned in this Chapter. The value of these operant studies would seem to be the fact that they employ procedures which encourage the formation of skills which are fundamental to the operation of the more traditional kinds of teaching machine so far discussed, as well as the general value that they offer the possibility of a simpler kind of teaching machine which may be suitable for more children than these machines.

We shall now turn to a discussion of a study by Friedlander et al. (1967) which describes the use of a piece of apparatus very similar to those used in the above studies, but which the authors clearly see as in the realm of 'programmed instruction'.

The work of Friedlander et al. is in many ways an improvement upon these operant studies. Although they use the typical arrangement of levers and control apparatus, the particular way in which they use them and the rationale they provide for their use make the study of immediate value for the educator, unlike the studies of the earlier workers. Probably the reason is that Friedlander et al. have been more closely concerned with the problems of devising educational methods for the institutionalized subnormal (see McCarthy et al. 1969).

Friedlander tackles what is undoubtedly a difficult problem in the education of the severely subnormal - that of measuring the cognitive functioning of the young S.S.N. child. There appears to be very little discussion in the psychological literature of how this might be done (c/f Mittler, 1970); one way is to provide a descriptive account of the child's progress along the 'norms of development' according to one of the many scales developed with normal children. One other way is to use the more dynamic method of relating the child's abilities to Piaget's analysis of the growth of cognitive development in the child. It is argued that the former method gives a sparse description of the child's functioning in comparison to the latter, but offsetting this is the comparative difficulty of assessing the child in Piagetian terms to that of using a child development schedule. Friedlander's approach here is to use operant conditioning to evaluate two young S.S.N. children, in terms of their functioning in different areas suggested by Piaget's analyses of early intellectual development. Quoting from Friedlander's paper, the rationale for this approach is clear-cut:

> "According to Piaget ..... the foundation of all intellectual development is laid in the sensorimotor period of the normal child's first two years of life. It is held that in this period the infant passes through a succession of stages during which he acquires the capacity for sustained, intentional, purposive, selective, and adaptive behavior. A principal mechanism by which these capabilities are acquired is said to be the infant's pursuit of 'interesting' sights and sounds that he causes to occur by means of his own activity. In the course of what appears to be random and repetitive play, he observes

rhe conseqences of his own actions. He makes things happen by his own effort, and becomes progressively more aware of cause-effect relationships that he controls himself, or that are the results of external events." (Friedlander et al., 1967, pp.909-910)

As a result the baby comes to gain increasing control over the events happening around him. Friedlander et al. go on to point out that the observation has been made that many retarded children fail to advance beyond the sensorimotor stage of development, but it is not clear why this should be so. It seemed to these workers that such understanding could perhaps be gained by a closer examination of the nature of the psychological processes that occurred during the sensorimotor period. Friedlander et al's. general interpretation of the nature of the processes during this period suggested that operant techniques might be particularly suitable for studying them.

The operant apparatus used in the study consisted essentially of two transparent plastic knobs, in each of which a small red light blinked continuously to attract the child's attention to them, which were connected to control apparatus which presented auditory feedback to the child depending upon which knob had been pressed. Pressure upon one knob resulted in a single stroke of a chime, pressure upon the other in an ascending scale of organ notes which lasted for as long as the knob was depressed. Every three minutes the function of each knob was automatically changed to that of the other.

Four infants were tested. One could not be induced to make voluntary successive responses, in another no pattern could be seen in his results. The other two made 'appropriate' responses and were therefore considered in this paper. Other children tested subsequently were said to have made similar performances to the children described here. The spontaneous play of the two children was apparently non-existent, their general 'behavior repertoire' sparse. Administration of the Cattell Infant Intelligence Scale yielded an M.A. of 0-10 months for one child ('J.P.'), and the Gesell Developmental Schedule 24-40 weeks for the second child('M.W.').

At the beginning of the test sessions the children were placed (J.P. sitting and M.W. lying supine, head towards the knobs) between the manipulanda and left alone. Each then showed interest in the knobs, manipulating them for a short period of time. After a pause in responding they resumed play with them - play which, according to the 'ward attendants' was more attentive and involved than was characteristic of either child when offered a new toy. M.W. appeared during the 36 minutes of the study to prefer the sustained feedback, making three times the length of responses to the organ notes than to the chime. During the experimental period he actively played with the knobs for just over half the time, making 749 separate responses.

J.P. played for about one third of the fifteen minutes he remained in the experiment, again showing three times the length of response to the organ than to the chime. The ward attendants reported that they had never before seen the child so active.

Discussion

The value of the study of Friedlander _et al_. has been in its illustration of the feasibility of thinking of operant apparatus as a teaching machine suitable for the more severely retarded. While only two children have been mentioned as responding to the apparatus in this study, it would appear that the machine is capable of being more widely used to judge from the comments of the authors that other children have worked upon the machine. Similar problems do, of course, arise in determining how widely the machine may be applicable to, for example, the running of a hospital ward but it would seem that such a machine could be fitted into a wider educational programme. A study of the development of an educational programme on a ward in an American subnormality hospital (McCarthy _et.al_., _op.cit_.) included the 'PlAYTEST' apparatus in the battery of educational procedures, for example. It should be noted, however, that the apparatus was used flexibly in this study. An assistant was made responsible for studying the day-to-day responses of children to the device and re-programming it accordingly. Thus, the apparatus was used not as a single teaching machine but as a collection of units for presenting stimuli and reinforcement, the operation of which could be changed according to the needs of the children. It was probably this feature of 'PLAYTEST' which permitted McCarthy _et al_. to comment:

> "No lower limit in chronological or developmental age for the operation of these devices was suggested by our data." (_op. cit_., p.116)

(7) The use of teaching machines with adult, 'asphasic' patients

A considerable body of research has come from studies with adult, brain-damaged ('aphasic') patients conducted at the Veterans'

Administration Centre in Los Angeles since 1963. Inspired by Skinner's writings on the use of teaching machines, they set themselves the task of seeing whether these principles had anything to offer in the assessment and training of these patients. After some initial studies with a machine requiring subjects to press buttons according to whether stimuli displayed were 'the same' or 'different', they began using a matching to sample machine of their own design.

The rationale behind using teaching machines with aphasic patients was a two-fold one. Firstly, they suggested a suitable means of communicating with patients for whom the presenting symptom was largely one of a difficulty in communication:

> "A major characteristic of aphasia, in fact, one which defines the condition of aphasia, is the breakdown in the communication process - i.e., speech and comprehension - one of the aphasic patient. Because of this communication barrier, it is often difficult, if not impossible, to assess accurately the residual capabilities in the aphasic by standard test devices. For example, the inability of an aphasic to point to a spoon presented to him with a variety of other simple objects may be due to his inability to comprehend the tester's verbal instructions, or due to an inability to associate the sound 'spoon' with the visual object 'spoon', or due to an inability to discriminate visually the spoon from other objects. Therefore, the first step in the present project involved establishing a reliable means of communication with the aphasic patient which obviated verbal instructions. This involved a pretraining stage to shape the desired behavior - in the present case, a left or right button press, depending on the position of the 'matching' stimulus in a 'matching-to-sample' task. Once the button-pressing response was within the S.'s repertoire, the next stage was to use this simple response to examine accurately and objectively the form discrimination learning of aphasics." (Filby and Edwards, 1963; p.26).

The second reason for using machines with such patients related to the general advantages of using machines with students of any kind, which Skinner outlined in 1954. But, for clinical populations, these advantages could be especially important. Filby and Edwards provide a good explanation:

> "..... a teaching machine has infinite patience; it goes as slowly as the student desires; it is as repetitive as necessary, and it can provide the precise contingencies of reinforcement emphasized by Skinner (1954) - i.e. frequent positive reinforcement, with minimum delay, of a response. Where extensive repetition is required for learning a given skill, such as arithmetic or speech, or even where simple visual or auditory discrimination are involved, the assignment of a human instructor to this routine repetitive drill function is a considerable waste of time and expense, especially where it is possible for some mechanical device to carry on these functions. The teaching machine could, thus, be an ideal tutor for slow learners and clinical populations such as aphasics." (op. cit. pp.25-26).

The procedure of the experiment, in line with this rationale, was firstly to establish the matching response in twelve experimental subjects on the teaching machine (a device basically similar to those alrady described in this and in the preceding chapter; correct button-pressing responses to the stimuli displayed by slide projects on the machine's display panels led to the illumination of coloured lights. Incorrect responses led to a ten-second Time-Out period, during which the screen was blacked out and the machine was inoperative) and to then investigate the extent to which matching or responding broke down in the face of different teaching materials.

The machine training phase, during which the matching response was gradually shaped, seems to have been effective. Two subjects failed to reach the matching criterion and were discarded. No data is given concerning the time needed to teach matching to the other subjects.

The form discrimination programme consisted of 118 items or slides. Each slide contained random forms, ranging from three-sided figures to thirteen-sided figures, constructed according to Attneave's (1957) method. The items of the programme made from these 'nonsense shapes' (Figure 3.3) were ordered in ascending difficulty of discriminability by an a priori method developed by Attneave[1].

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(1) the method, and full equation is given, not here, but in Edwards (1965)

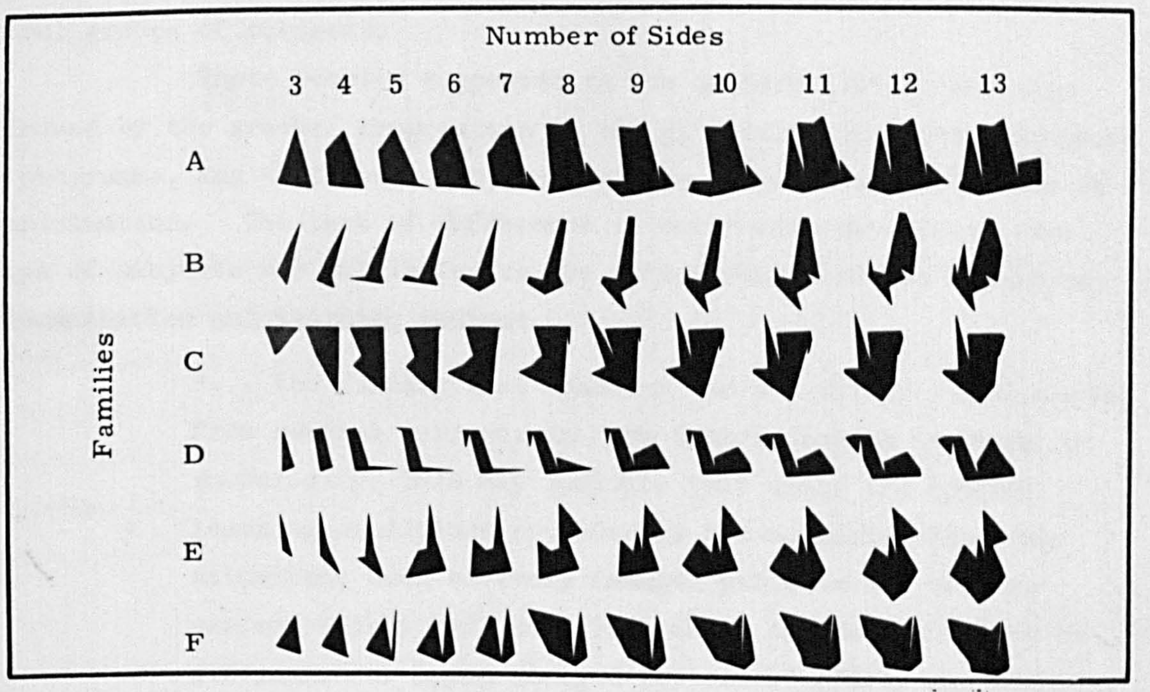

Figure 3.3

Nonsense shapes derived from the method of Attneave (1957), and used in studies by Edwards and Rosenberg (see text). The illustration shows the division of shapes into 'families' (extensions from different three-sided shapes) into figures having the same numbers of slides. See text for further explanatiфn.

Results showed a low error-rate throughout the programme for both aphasic patients and a group of non-brain-damaged control patients, and a gradual increase in errors as the programme continued. There was no significant difference in error rate between the experimental and control groups of subjects.

These results suggested to the authors that errors were minimized by the gradual progression in the difficulty of items throughout the programme, and that there was, in fact, an increase in difficulty of discrimination. The lack of difference in error-rate between the two groups of subjects was attributed to the effectiveness of the method as a communication and teaching medium:

> "... the finding that aphasics did not differ significantly from control subjects in form discrimination learning is encouraging. This may indicate that under the optimal learning conditions provided by the automated-teaching situation, even severely damaged patients are able to perform fairly well on a task which has been shown to be difficult for brain damaged patients." (Filby and Edwards, op. cit., p.32)

This basic methodology having been established other studies applied it, firstly, to problems in the non-verbal assessment of the capabilities of such patients and, secondly, to the remediation of these problems.

For example, Filby et al. (1963) investigated the abilities of ten aphasic patients to discriminate between words when three word parameters were systematically varied, these three parameters being word-length, word-frequency, and word-similarity. These variables had, according to these writers, been shown in previous research to be relevant to the language of aphasic patients but in this research their respective roles had been confounded. This study hoped to yield a more definite picture of these roles.

Results showed that very few errors in discrimination between words were made either by the aphasic patients or by non-brain damaged control patients and that no differences in number of errors made by these groups occurred with respect to the different word types. In terms of reaction time to the stimulus array, however, it was found that aphasics showed longer reaction time to stimuli involving increased word length, whereas that of the two normal control subjects remained stable. No selective impairment of the aphasic patients occurred with respect to the other two word variables. This, therefore, indicated more clearly, apparently, than had previous research the roles of these three variables in the discrimination of words by these aphasic patients.

Rosenberg and Edwards (1964) made a similar use of the automated procedure for assessment but extended its use into the sphere of training.

Five aphasic and five control patients were compared in their response to three perceptual discrimination programmes presented on the apparatus. The programmes, composed of shapes based upon those necessary to form English capital letters, were concerned with the variables of shape discrimination, orientation of form, and the transition of discrimination in terms of solid shape to discrimination in terms of outline figure.

The results indicated that aphasic and control patients differed significantly in response latencies and error rates to sets of pre-test items selected from each programme.

The aphasics were then given training with the machine with those programmes on whose pre-test they had had an error rate greater than 10%. On follow-up testing one week after training, response latency decreased and differed significantly from pre-test latency, and the error rate became comparable with the normal control patients.

Thus, in this study, the machine and programme apparatus were successfully used to assess an area of difficulty in the functioning of these aphasic patients and then to go some way to remedying it. It is interesting that this study (which was later extended by Rosenberg (1965)) is achieving a form of assessment in an everyday setting which has been remarked upon as a worthwhile possibility for other handicapped patients in the work of many of those mentioned in this and in the preceding chapter. What is particularly valuable about these studies with aphasic patients is the way in which areas of difficulty of relevance to the study of aphasia are being examined, not just the practicability of an automated device.

Subsequent papers described increases in the technical sophistication of the apparatus. Edwards (1965) reports the introduction of a variety of reinforcing events, given according to the preferences of the subject, and the use of a buzzer by the Experimenter to interrupt incipient error patterns. The sequencing of the programmed material, while basically progressive, involved revision items, and a 'branching facility', which enable subjects to jump ahead or fall back in the programme according to their performance on intermittent 'test slides' appearing at intervals in the programme. Rosenberg and Edwards (1965) note the tendency for subjects to touch the pictures displayed on the screen of the machine before responding to the buttons; adapting the machine so that it could be operated by touching just the picture on the panel seemed to be appropriate, and was incorporated. In addition, the use of a branching programme (technically, it would probably be known as a 'skip-branching' programme), mentioned in relation to their earlier method, was automated. Basically, this machine consisted of 'programme phase units' each consisting of 24 programme frames. These phase units were circular pieces of plastic with the 24 frames mounted in them, stored in (of all things!) a juke box. If the programme called for Phase 1 to be presented to the subject, the juke box would retrieve this (as it would normally have retrieved a record) and would mount it in the projector. The record playing table of the juke box would move this according to commands from a paper tape reader until slide 1 was presented. If the subject responded, the machine would deliver the appropriate reinforcement to him (predetermined by E). The machine would record the subjects' performance noting, in particular, his performance on certain test slides which appeared at intervals in each programme phase. If he responded correctly on these, the machine would move on to a later part of the programme. If the subject at any point performed wrongly on the test slides, however, an appropriate remedial sequence would be presented. The apparatus is described in detail by Edwards and Rosenberg (1966), the operation of a typical skip branching sequence by Edwards (1965) and Rosenberg and Edwards (1965).

Discussion

Many similarities are present in the aims and methods of these studies to the ones that have been reported so far. The authors have seen particular advantages in the use of a matching to sample machine in the assessment and teaching of subjects and they have developed experimentally a method to teach the operation of the machine to the subjects before using this procedure as a testing and teaching medium in various perceptual skills. In two ways, however, they have made valuable extensions of this general approach. Firstly, they have pushed on past the difficult points of initial development of the machinery and problems of accustoming patients in its use, past that of studying some aspect of discriminative performance apparently for its own sake, into the study of items of significance for the mental functioning of the patients in their charge. Secondly, they seem to have engineered the procedure into an everyday treatment situation as opposed to a conventional laboratory situation.

Some specific procedural points of interest. Firstly, their eventual adoption of a machine which required the subject to press the panel of the machine in preference to a button indicated that this mode of machine operation is somewhat easier than that of button-pressing for these subjects. Secondly, it appears that some of these subjects experienced difficulty in matching to sample in the initia stages of their work with the machine, which was reduced by the use of an appropriately designed fading programme. Even so, some of them apparently developed incorrect response habits which, it appeared, were best 'treated' by E. watching them and pressing a buzzer when they appeared. These points both indicate that these subjects were in some ways similar to S.S.N. children working on a machine involving matching to sample and suggest different ways of aiding children over these difficulties. Finally, the use of a complex and comprehensive machine with 'branching' programming would seem to be an indication that any simple selection of programme material and of the means of presenting it would be inappropriate in practice, and that full value of such a programmed approach might come only from such comprehensive apparatus. Even so, cost is an important factor, as is size; it is interesting that comparatively little has been done with the 'Talking Typewriter' designed by O.K. Moore (1963, 1966) and produced commercially by the Rank Organisation in Britain. This is a comprehensive machine consisting of facilities for presenting auditory and visual programme materials and a typewriter key-board for the pupil's "answers". The machine has been used in the teaching of reading to illiterate adults (Hill, 1969, 1970), to adults from an Adult Training Centre (Moseley, 1970) and to a variety of other subjects, including immigrant, autistic, and "dyslexic" children[1]. Some of these children

(1) Details of case histories of some children who have used the 'Talking Typewriter' are presented in a report issued by the British manufacturers of the device (Rank - R.E.C. Ltd., 11, Belgrave Road, London, S.W.1) entitled: "The Edison Responsive Environment - the 'Talking Typewriter'". (Anon.)

have responded well to the machine but it is doubtful whether it has had the value its price (£16,500 in 1970; £9,000 in 1972) would seem to warrant. In Britain, at least, it has not had widespread physical acceptance; only one machine was, in 1972, in use in Britain (Romizowski, 1972). The is probably due in part to its cost, to the fact that it requires semi-permanent installation, to the fact that no comprehensive library of programmes is available for it, and to the reserved conclusions of some evaluative studies conducted with it (e.g. Moseley, op.cit; Brown,1971).

(8) Discussion and conclusions of Chapter 3

In this chapter we have discussed the work of Bijou and Staats with subnormal children, some of whom had I.Q.'s below 50 and Mental Age's below 5 years; Sidman and Stoddard's studies with institutionalised children with I.Q.'s or S.Q.'s below 40 (1967) and their studies with a mixture of subnormal and normal children (1966); the work of Morgan with E.S.N. children; the work of Friedlander et al. (1967); and some operant studies; and the work of Edwards and Rosenberg et.al. with adult 'aphasic' patients. Before drawing conclusions from these studies and relating them to the studies of young normal children mentioned in Chapter 2, let us briefly remind ourselves of the content of these studies.

Both Bijou and Staats began using the procedures they had devisedfor young normal children with subnormal children. Both found that these procedures were generally serviceable for use with the latter, but both had to adopt modifications to the procedures. Staats concentrated mainly on interposing transition stages in the programme to smoothe the transfer from one part of his reading discrimination programme to the next, adopting ad hoc modifications for each child. Bijou took the different approach of making radical modifications to his training procedures with his teaching machine. Believing that the reinforcing properties of the machine were having less impact on the subnormal children than on the normal, he required the former to undergo a revised instruction procedure with the machine which aimed to draw the child's attention to the fact that he ought not to make a 'wrong' response, and to establish a baseline measure of responding to the machine which might enable more sensitive analysis of the children's responses during the orientation-training programme. He unfortunately did not describe any detailed results of the modified procedures, but merely notes that the methods had been ineffective in teaching the discrimination of the difficult orientations.

Sidman and Stoddard systematically devised a programme to teach the discrimination of a circle from an ellipse, in which 'fading' was the principle teaching technique. Having devised what they believed was a maximally effective teaching programme, consisting of eighteen programme slides, after a series of revisions tried out on different groups of normal and subnormal children, they used a group of S.S.N. children in an attempt to evaluate the effectiveness both of the finished programme with these children and also of the effectiveness of 'fading' over mere differential reinforcement of correct responses in teaching the discrimination. The study showed that fading was a considerably more effective method of leading the child to make the discrimination correctly than was mere differential reinforcement of correct responses. It also showed that, even with this highly revised teaching programme, some S.S.N. children made errors, although all in the 'fading' condition managed to reach the end of the training programme.

Morgan's matching to sample teaching machine represented a departure from these first three studies, which were similar in style. His machine, while aiming to teach discriminations, relied on an extensive verbal commentary to join the frames of the teaching programmes, rather than upon the 'fading' of visual aspects of the programme frames. One other major difference between his use of a machine and that of the others was in its incorporation into the everyday teaching of his school. Morgan is, of course, a headmaster and not a psychologist - which perhaps accounts for these differences. Marshall, similarly, has shown a teacher's emphasis in managing the successful introduction of machines into everyday teaching; but not, however, without some initial reluctance, apparently, on the part of other teachers. Morgan, similarly (1970), reported an initial opposition by teachers in his school.

The 'free-operant' studies involved types of 'teaching machine' which required similar, but apparently simpler, shills to those required for the other machines described so far. Although there seemed to be no detailed accounts of how S.S.N. children could repond to the various pieces of operant apparatus it seemed that they were potentially suitable for many such children and, in the study of Friedlander _et al._, good results were obtained with two young institutionalized children. In this last named study the use of a Piagetian framework for conceptualizing the work seemed a valuable development from ealier studies.

The studies in the use of a teaching machine with adult aphasic patients seemed to show the successful development of some of the aims of the similar studies described in this and in the preceding Chapter, in the authors' use of it in a hospital setting as a means of assessing and remediating some of the specific cognitive deficits apparently associated with aphasic patients. The development of a complex and comprehensive teaching machine suitable for such patients was described, as well as some of the studies conducted with it which aimed to assess and improve specific areas of discrimination performance.

Let us now take the six groups of studies discussed in this Chapter and draw conclusions from them in terms of the five 'points of information' required for our intended analysis of the use of such machines with the S.S.N. child.

Point 1 : Each of the machines (or pieces of apparatus) described in this Chapter resemble that described by Skinner as suitable for normal and handicapped children and are therefore appropriate, potentially, for fulfilling his aims for such machines. Each of the studies has clearly been influenced by Skinner's beliefs, although Morgan shows a certain independence from them.

Point 2 : Bijou (1968) noted that children with I.Q.'s ranging from 32 to 66 and M.A.'s from 3 years 10 months to 8 years 10 months found his machine attractive, in that they seemed enthusiastic about coming to his laboratory for repeated sessions and were, moreover, keener in this than were the young normal children of pre-school and primary age. Bijou does not, however, give precise data about the number of responses children made to the machine or the amount of time they were willing to spend at it. Towards the end of his studies, however, data was obtained on 12 children with M.A.'s ranging from 3 years 10 months to 6 years 3 months who were required to reach a stable rate of responding; these boys took from 4 to 17 sessions to reach such a stable rate, suggesting that the machine was attractive to the children.

Other studies have noted few occurrences of subjects not finding such machines attractive, so that it would seem that S.S.N. children would be likely to respond well to such machines as the Touch Tutor. On the other hand, it must be amphasized that there has not been the opportuntity to consider the responses of many S.S.N. children in detail, so that it is difficult to predict how many such children would do so. In addition, the studies cited have not mentioned the extent to which their groups of subjects are representative samples; it could be that subjects who have not responded to the machines have been excluded from study.

One final source of information on this point which is relevant is data from operant studies in which lever-pulling or some related task has been studied over periods of time.

For example, Watson et al. (1968) studied the behaviour of 17 S.S.N. boys over a number of sessions in a plunger-pulling task; it appeared that poker-chips which were exchangeable for 'candy and amusement reinforcement' were effective in maintaining behaviour over 23 sessions in 3 subjects and over a further 70 sessions in 7 subjects. The remaining subjects acted as control subjects and were given social reinforcement instead of poker chips. Their pulling began at a high rate but extinguished after approximately 5 sessions. As another example, Ellis et.al.(1960) studied a group of 12 S.S.N. adults with I.Q.'s of 30 or less over a period of 30 daily half-hour sessions, during which responding was maintained, in the majority of subjects, at a high rate of approximately one response every two seconds. A second group of subjects, with I.Q.'s ranging from 30 to 70 and M.A.'s ranging from 3 years to 9 years were run on the same task of lever-pressing for a period of 15 days, during which their behaviour was maintained at a high rate. By the 15th day the group was responding on a Fixed Ratio schedule of 1024 responses per reinforcement with a mean number of approximately 4,500 responses in a 30 minute period. Other operant studies suggest that S.S.N. subjects in general have a similar liking for such tasks, although it is difficult to determine the representativeness of subjects studied in many of the reports (it seems to be typical practice in such operant reports to concentrate upon the behaviour of individual subjects, a practice encouraged by such workers in genera who believe the experimental analysis of the single case to be of more value than taking the average behaviour of groups of subjects (c/f Skinner, 1959).

Point 3 : It would appear that the operation of matching to sample machines is harder for subnormal than for normal children of similar Mental Age, to judge by the difficulties Bijou, Staats, and Sidman and Stoddard had in the use of their machines with mildly and severely subnormal children. Particular problems in this respect seemed to lie in the ineffectiveness of reinforcement contingencies in controlling behaviour together with the appearance of 'extraneous behavior', both noted by Bijou, the difficulty found by Staats in the verbal control of children's behaviour, and in an increase in error patterns noted in Sidman and Stoddard (1967). These difficulties led Bijou and Staats to adopt marked changes in their procedure, and it might be supposed that a more fruitful approach would be to do as Marshall, Friedlander et al. and Edwards et al. did and to begin work from the start with these different groups of handicapped subjects.

Again, it is difficult to determine how many S.S.N. children have found the task of matching to sample difficult. One would, however, expect, on the basis of our conclusions concerning this with young normal children and on the comparison studies of Staats and Bijou, that children would have difficulty in the task both in its acquisition, and execution with difficult stimuli to discriminate. If the teaching material is carefully sequenced it would, to judge by the experience of Sidman and Stoddard, those who worked with aphasic patients and by Staats, that the difficulties experienced by children may be lessened. One other way to achieve this, it would seem from the experience of Bijou, would be to allow children repeatedly to work on the same programme material until well practiced at it. One might also expect that the variables we have seen to be apparently relevent to the acquisition of young normal children of this task, namely Mental Age and the 'split' type of machine operation, could also be relevant to its acquisition by handicapped children.

Point 4: Little discussion has been given of the use of machines such as those described in this Chapter by teachers in the classroom setting. Such use would appear to be possible for the mildly retarded child, however, to judge by the experience of Marshall and Morgan. One drawback is, again the fact that the machines used appear to require semi-permanent installation, and have so far been involved in various adjustments to suit the needs of the subjects.

Point 5: Little discussion has occurred of what machines of matching to sample format may be used to teach. Bijou demonstrated the possibility of improving discrimination skill by his 'fading' programme but noted that children made many errors in the course of the programme, with children of lower M.A. performing less well than children with higher M.A. in this respect. It is thus difficult to learn what children did gain from this programme. Staats has suggested the possibility of children being able to acquire the names of letters and letter - combinations although no extensive data concerning this has been given.

Edwards _et al_. suggest possibilities of the matching technique being used to improve discriminationperformance on similar English words; the studies of Sidman and Stoddard similarly suggest the possibility of this but give little discussion of the extension of the technique.

The work of Friedlander _et al_. suggests that machines may be used with good effect to give 'stimulation' and to encourage motor acitivity in the more severely retarded. This is one area of the use of such machines which has so far been neglected but which could fruitfully be extended.

Finally, the work of Morgan gives evidence that a matching to sample machine could be used to present a wide range of subject matter to children. It should, however, be noted that his machine, in giving extensive verbal commentary, has a completely different emphasis than other machines we have discussed, which are predominantly visual in the presentation of material.

In conclusion, it seems that S.S.N. children may respond well to matching to sample machines like the Touch Tutor but that they are likely to have difficulty in operating them. This difficulty may be overcome in some children by special techniques designed for this but, even so, some children may persist in responding with patterns of incorrect responding. Precise figures about the extent of these difficulties and about how they may be overcome are not, however, available and little discussion has been made of the nature of incorrect patterns of response. Similarly there has been little discussion of how such machines may fare in wider, classroom use and of what may be taught by them.

Having thus considered studies in the use of machines similar to the Touch Tutor with young normal and with various groups of educationally handicapped subjects we now shall turn to the Touch Tutor machine itself and consider details of it.

CHAPTER 4: THE 'TOUCH TUTOR'

(1) Historical Introduction

In 1965 two psychologists at Birkbeck College began developing a teaching machine which they hoped would be suitable for research work in visual perception, and possibly in education, with children whose mental age fell below about seven years. No commercially available machine was suitable for these children who required a machine which was an attractive 'toy' and who could not follow written instructions or make written responses on a machine.

The outcome of their work was a machine they called the 'Touch Tutor'. It required the child to match to sample and reinforced him for responding correctly by 'speaking' the name of the stimulus object to him. Initial studies with pre-school and severely subnormal children yielded what they regarded as encouraging results and they continued to develop the machine with grants from a firm of psychological instrument manufacturers (Behavioural Research and Development Limited, of Teddington, Middlesex) the Spastics Society, and the S.S.R.C.

The first published descriptions of the Touch Tutor consisted of general accounts of the machine and brief descriptions of the preliminary work conducted with it (Cleary and Packham, 1968a,b; Mayes, 1968) and a technical account (Cleary and Packham, 1968c). These introductory accounts offered, above all, a general rationale for the machine. Consider, for example, this extract:

> "... a new teaching machine [was devised] with the aim of solving some of the problems encountered when certain basic skills, such as the ability to read instructions or to press a series of buttons, cannot be automatically assumed. The system evolved is, therefore, intended for teaching young children who have not yet learned to read; adults and children of subnormal intelligence; and those under certain forms of physical handicap. Whilst retaining the essential requirement that the student should make frequent and observable responses, the machine creates an environment in which written or other symbolic materials is meaningfully related to its pictorial and auditory equivalents. (1968b,p.1)

But in addition they explained the various special features in the machine's mode of operation which they had invented - electronic touch detection, a 'performance computer' to inform E. when S. had reached criterion performance, verbal reinforcement for correct responses, and 'endless' programmes of teaching material. Briefly they reported that studies had been carried out with children (Huskisson et al., 1969; Harper et al., 1971) but left more detailed accounts for these papers.

Having thus sketched the origins and first work with the Touch Tutor a more detailed account will now be given, concentrating on details of the machine's mode of operation and on the experiments conducted with it.

(2) Construction and Operation

The Touch Tutor Mark II consisted essentially of an automatic slide projector and an endless loop tape player connected electronically to a touch sensitive display panel. The various components and circuitry were located in a lockable, mental cabinet, giving the machine a weight of 88lbs. and a size of 20"x 19"x 28". Pictures of this machine, with which all the experiments referring to the 'Touch Tutor' in this volume were conducted, are given in Figures 4.1 and 4.2.

Visual teaching material had to be photographed and prepared on 36mm. slides and loaded into the rotary magazine of the slide projector. The auditory equivalents of the stimuli had to be recorded on standard magnetic recording tape and loaded into the endless loop cassette of the tape player. A typical slide from the first teaching programme supplied by the maker ("-2") is shown in Figure 4.3. The white segments at the top and bottom of the slide (which the child would not see) are codings which enable the machine, via photocells, to differentiate correct from incorrect responses (lower codings) and to render the panels touch-sensitive (upper codings).

Cleary and Packham supplied a 'programming manual' with each machine sold. It advised the user to distrubute programme material randomly throughout the programme of 100 slides, and to prepare the position of correct choices on each frame according to an essentially random sequence (in fact, they advised the use of a Gellermann (1933c) series, in order both to minimize the occurrence of incorrect patterns (or 'habits') of responding as well as to ensure that only correct

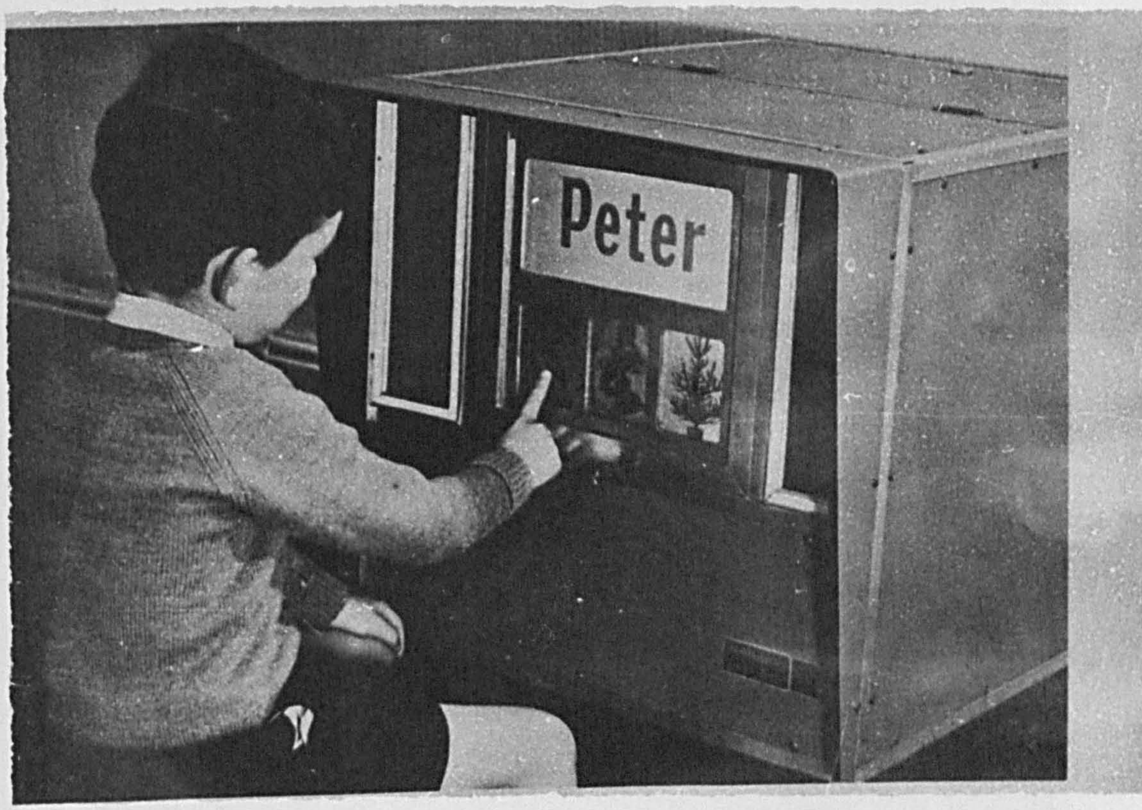

Figure 4.1

A child responding to the 'Teddington Touch Tutor Mark II'. A typical 'reading' slide from one of the makers' programmes is displayed on the stimulus panels of the machine.

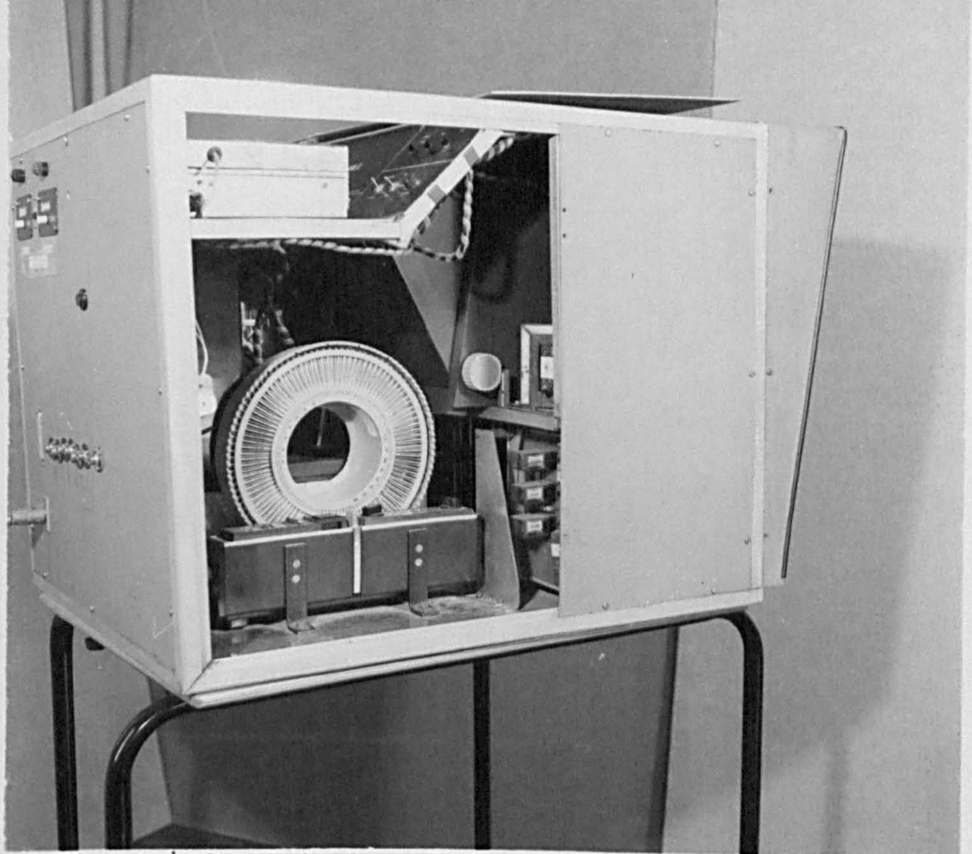

Figure 4.2a: Interior of the 'Touch Tutor' with the lockable door removed. The sockets and digital counters on the rear of the machine were not standard fitments.

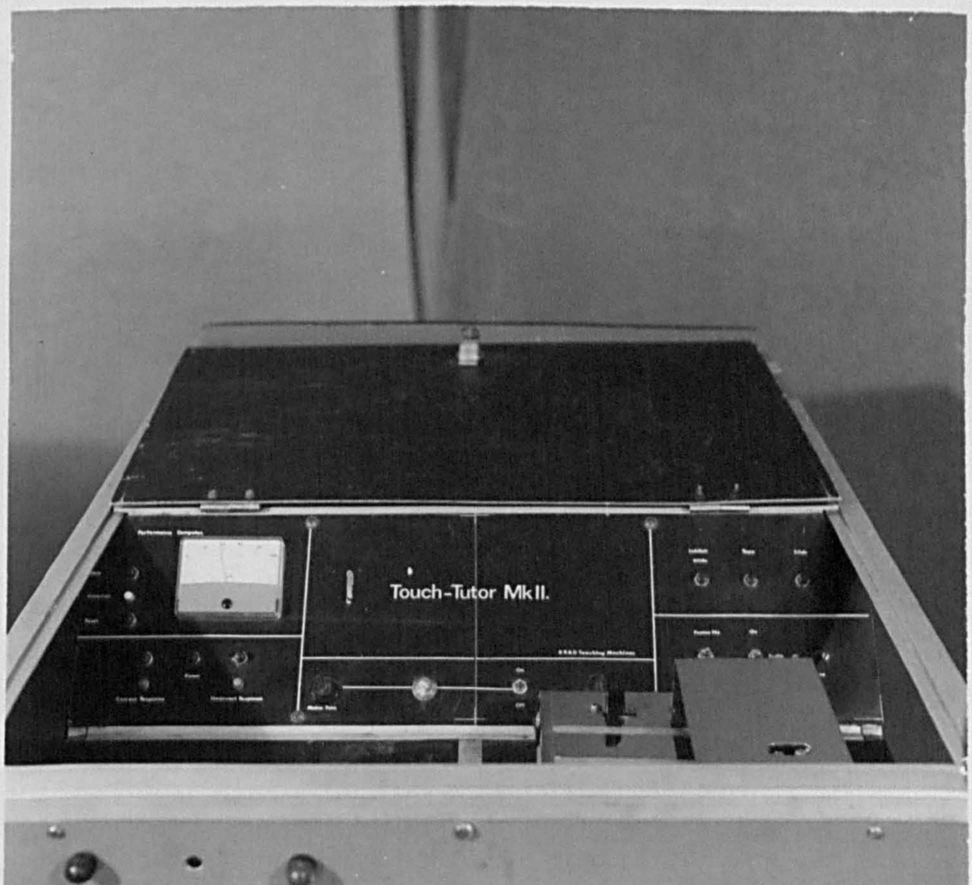

Figure 4.2b: The control panel of the 'Touch Tutor'. The tape player is on the right of the picture.

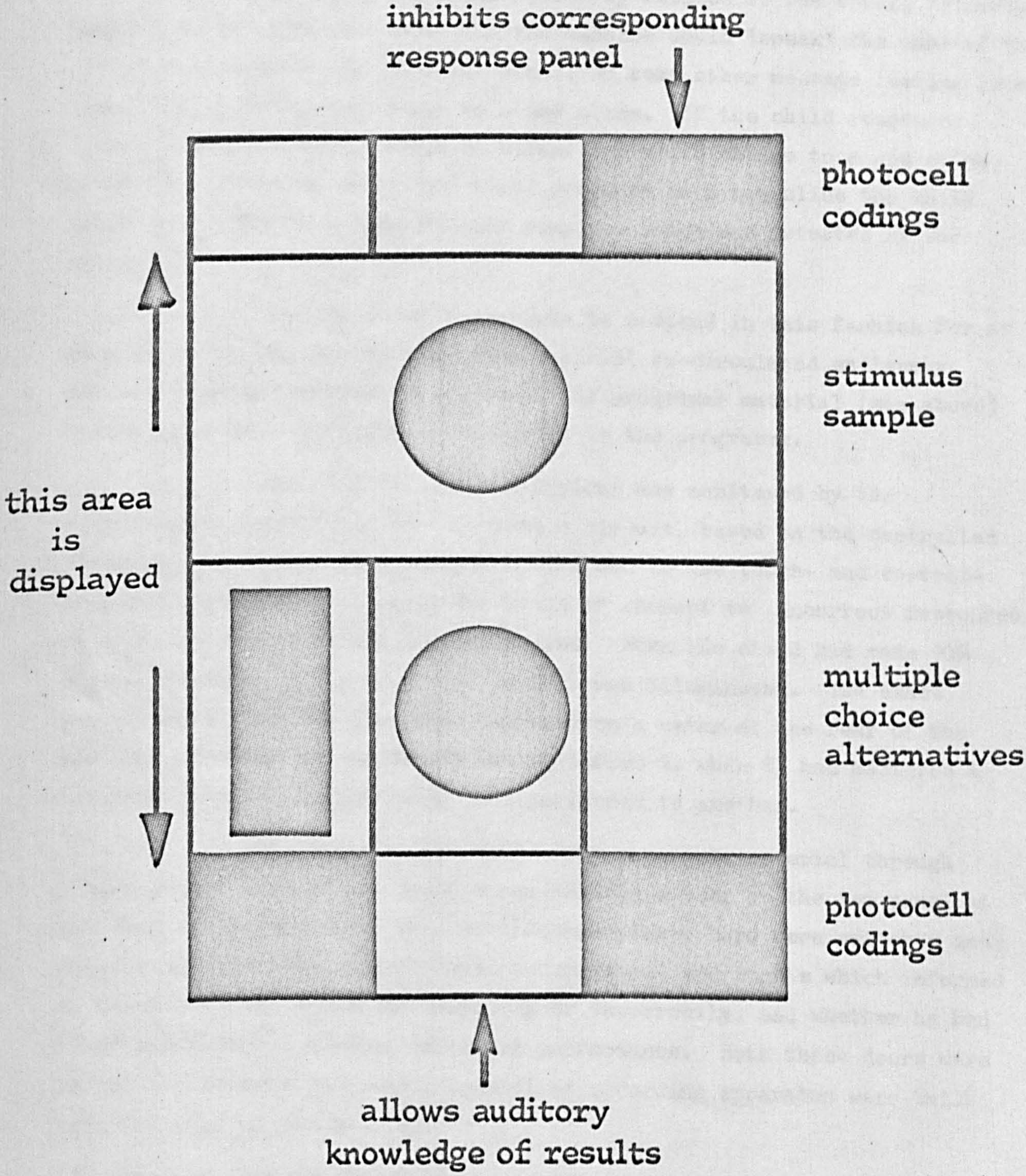

Figure 4.3

A typical slide for the 'Touch Tutor' from the makers' "-2" programme.

matching performance would result in criterion scores).

The child, sitting in front of the machine, had to touch the lower, 'response' panel which correctly related to the upper, 'stimulus', panel. If he responded correctly the machine would 'speak' the name of the object displayed on the stimulus panel, or some other message lasting less than five seconds, and change to a new slide. If the child responded incorrectly the machine would be silent but would change to a new slide after five seconds. After his first response to a new slide the child could not, therefore, make another response which was detected by the machine.

The child could continue to respond in this fashion for as long as he liked, for the programme material re-circulated endlessly. The essentially unsequenced nature of the programme material (see above) allowed the child to begin at any point in the programme.

The child's choice behaviour was monitored by the 'performance computer'. An electronic circuit, based on the controlled charge and discharge of a capacitor attached to the touch- and correct-response circuits, calculated the ratio of correct to incorrect responses over the 19 slides before that displayed. When the child had made 90% of the previous 19 slides correct a bulb was illuminated. The exact percentage at any one time was displayed on a meter at the rear of the machine. The aim of the device was to inform E. when S. had mastered a programme and could fruitfully be transferred to another.

The experimenter could load programme material through a door in the side of the machine and through a door in the top panel at the rear of the machine. Next to the tape player here were switches and buttons by which the machine could be operated, and lights which informed E. whether S. had responded correctly or incorrectly, and whether he had (from the 'meter') reached criterion performance. Both these doors were lockable. Sockets for remote control or recording apparatus were built into the rear of the machine.

(3) Studies with the Touch Tutor

Huskisson et al. (1969) investigated the responses of 18 pre-school normal children aged 3yrs. 10 mths. to 4yrs. 10 mths. to the Touch Tutor under three experimental conditions.

Initially, as 'condition 1', children were instructed in matching to sample with a series of picture-matching slides and allowed to work on the machine until they had reached criterion. 17 children reached this criterion in an unspecified number of sessions.

On reaching criterion, children were transferred to the second experimental condition. In this they responded to a series of picture-word matching slides, where the stimulus was a picture and the response item a word. They saw four types of slide in this series, in addition to picture-matching revision slides from the first series of slides; slides with, for example, a cat at the top with the words 'cat' 'hat' at the bottom; slides with, for example, a cat with 'sun' 'Cat' at the bottom; slides with, for example, a sun with 'sun' 'dog'; and slides with, for example, a sun with 'sun' 'hat' at the bottom.

The aim of the experiment was to record which word the child would respond to first when a slide of one of these four types appeared, and whether the response was correct. It was expected that children would (a) respond more frequently ('prefer') and (b) respond more correctly to ('learn') the words 'dog' 'lip' 'pen' 'sun' - which were visually and auditorily different to each other - than to the words, 'bat' 'cat' 'hat' 'rat' 'mat' which were auditorily and visually similar to each other. This type of study was said to have implications for teaching at the beginning of instruction in reading.

Results showed that children did in fact respond more often to the 'unlike' words than to the 'like' words, and that they were more often correct on slides where an 'unlike' word was the correct alternative. The authors assumed that the children 'learned' to read these words and suggest that the experiment implies that in the early stages of reading the words used by the teacher for the child should be maximally different from each other.

After completing this experiment children were transferred to the third experimental condition. A reading programme (number O[1] in the maker's series of programmes) was used. Half of the children were given these slides with the machine saying 'you are doing well',

(1) This programme contained slides in which the stimulus item was a word and the response items pictures.

'well done' and so on; the other half of the children were given the slides with the machine naming the item as usual. In the first session, the only one analysed, children with specific naming of the stimulus item had a higher proportion of correct responses than did children with general encouragement; taking the number of responses made in the session as a measure of motivation there was no difference in the motivating power of the two conditions.

Harper et al. (1971) studied the responses of 16 S.S.N. children, ranging in chronological age from 9 to 16 years and in Mental Age from 2 years 9 months to 8 years 4 months. Further description of the children is restricted to the comments that they had spent from one to six years attending the hospital school but had received no formal instruction in reading.

Initially subjects were given a picture matching programme ("-2" in the makers' series of programmes) requiring the matching of colours, pictures, geometric shapes, and picture-word combinations. No instructions were given; to quote from the paper: "The children were left to discover the principle of matching to sample for themselves with the aid only of auditory knowledge of results from the Touch Tutor to confirm their correct responses and its absence implicitly to indicate errors." (p.2). Three subjects reached criterion in their first session; nine reached it between two and ten sessions, andfour did not reach criterion within this time. Sessions, one per week, lasted for approximately 20 minutes. Errors made on the four types of slide were analyzed; statistical analysis enabled the null hypothesis that the four conditions were equal to be rejected (i.e. that the case $C_1=C_2=C_3=C_4$ did not apply[(1)].

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(1) Harper et al. seem to suggest (p.5) that there were differences between each of these classes of stimuli, (i.e. that $C_1 < C_2 < C_3 < C_4$). This is an unwarranted assumption on the basis solely of the Friedman Two-Way Analysis of Variance by Ranks, which was used here. It is possible that the significant value of the statistic obtained from the application of the test resulted solely from a large discrepancy between ease of word-matching against all other stimuli, which is indicated by their Figure 5 (p.7).

Children who reached criterion were then transferred to a programme which required them to match, in half the slides the letters b,d,p.q, and m,w presented as the initial letters of similar words, e.g.

pear

pear mear qear (sic)

and a variety of other stimuli in the other half, namely picture-word combinations, randomly-arranged dots, with or without colour cues, and pictures-to-words. Three children reached criterion in this 'complex' programme, the others remaining close to chance in their performance throughout this stage of the experiment (how long this was is not said).

Results agreed with previous work with young normal children by Fellows (1965) and by others. Most errors arose in matching 'reversals' (e.g. p-q), less with 'inversions' (e.g. p-b) and least with rotations (e.g. b-q). Confusions of b,d,p,q, with the neutral letters m,w accounted for 13.4% of errors made by the three subjects who reached criterion and 31% of all errors made by the remaining children. For the other stimuli, 6 of the 9 children showed retention from the simpler programme by matching revision slides with fewer errors than expected; dot-matching was good, with 7 of the 9 subjects taking advantage of the colour cue when it was present; little improvement was shown on the more difficult task of matching picture-to-word.

The authors say little about the findings. With regard to the machine, they say that the rapid discovery of the principle of matching by three of the children was encouraging and that auditory knowledge of results was effective for 12 of the 16 children in reinforcing matching behaviour and maintaining it over many sessions. With regard to the data on reversals they note the substantiation of their findings with most of the literature in the field (although the reverse is more accurate). They say perhaps more about implications of their findings for the education and assessment of retarded children, noting the fact that 'some children' said the appropriate word in response to the pictures before the machine 'thereby interacting in a social manner with the teaching machine' (p.8). Some of the children, too, 'could not be satisfactorily assessed by conventional procedures, although all responded to the automated system'. They continued:

'The availability of detailed analyses of errors clearly could assist in the assessment of retarded children, diagnosis of specific disabilities etc., as well as in remedial training.' (p.9).

(4) <u>Discussion and Conclusions</u>

The Touch Tutor resembles the machines described in Chapters 2 and 3. In overall aim it fits Skinner's views about the aims of teaching machines in general and of a machine for pre- or non-reading subjects in particular, utilizing the principle of self-paced, self-instruction with a machine whose mode of response is suitable for the subject using it. It can provide a response by response record of the subject's behaviour, too, and may be used to provide the subject with frequent reinforcement, for correct responses.

It differs largely in terms of technical details having a sophisticated electronic touch detection facility, a 'performance computer', spoken reinforcement, and in the fact that it is self-contained. Unlike Bijou's machine it does not require the child to respond to the upper, stimulus panel before making a choice to the bottom panels. One other major difference lies in the fact that programmes so far designed for the machine are in no sense intended to present the child with a carefully ordered sequence of material of increasing difficulty, as Skinner recommended. Neither do they conform to any other programming 'style' or to the maxims of the programmed instruction fraternity that instruction should be a carefully planned and specified event.

In general it seems to offer a fairly attractive and convenient-to-use version of a teaching machine of traditional format. Physically, it is also immediately suitable for potential, everyday school use.

The study of Huskisson <u>et al</u>. has shown that one group of children from a pre-school play group easily learned to match to sample over several sessions with the machine. They continued to respond to a more difficult matching programme and apparently learned to 'read' several words while doing so. It thus appears that the Touch Tutor, for some pre-school children, can exert sufficient control over their responding to enable their responses to different classes of experimental interest to be studied. In this respect its use has been similar to the use made of similar machines by the workers described in Chapters 2 and 3.

The results of the study were only briefly discussed; more interpretation of the results either in terms of psychological theory or in terms of their educational implications would have been interesting. In addition, little was said about any wider implications of the results for the wider use of such machines with pre-school children.

The study of Harper et al. extended the use of the Touch Tutor to a sample of 16 children from a subnormality hospital school. 12 of the children learned, with no instructions, to match to sample in up to approximately 3 hours of experience with the machine and three of these children continued to match when transferred to harder matching tasks. The machine seemed to remain attractive to these children over several sessions and some children 'interacted' with it by speaking the name of the stimulus picture.

The results show that the machine could be usable by and attractive to some S.S.N. children, although it does not give more than an indication of the representativeness of the sample for other children in a hospital school. Again, little was said about the theoretical and practical implications of the findings but a theme present in many of the papers we have discussed in Chapter 2 and 3 recurred when the authors suggested the potential application for the machine in the training of such children; that is, the possibility was briefly mentioned, but not developed.

The lack of detail with which the parts of this study were presented makes it difficult to make exact appraisal of the responses of these S.S.N. children to the machine. Superficially, it does seem that their responses were similar to those of pre-school normal children: they responded to it favourably and some apparently learned to match to sample on it. Over several sessions they responded to it well so that it seemed to retain its attractiveness to them. They study, in common with previous ones conducted with similar machines, presented the machine in a favourable light but did not examine its potential use critically. Although, therefore, the machine might have exciting possibilities for the education and training of the S.S.N. the extent to which this potential is realistic is, from this study, but vaguely known.

In conclusion, details have been presented of a new teaching machine together with details of two studies with the types of children for whom it was designed. These brief studies have shown that such children apparently respond to the machine favourably, but although this finding suggests that the machine could have wider implications both for pre-school normal and for S.S.N. children such implications have not been examined even in cursory detail by these writers. It could, however, be argued that the brief nature of these studies has been such that they provide insufficient information for such an examination to be made. This is indeed true; too little information was given on the characteristics of the subjects for one to judge upon their representativeness to other populations of such subjects; the study was carried out in the setting of a purpose-built laboratory by the designers of the machine and the programme material used gave only a brief indication of the educational application of such a device to the curricula of these children. Clearly, information on these points would be needed before an adequte examination of the machine's educational potentialities could be made.

Even so, in 1968 when this thesis was conceived, the commercial manufacturers of the Touch Tutor were presenting it ostensibly as a mchine well suited to the educational problems and needs of S.S.N. children and others with similar problems:

"The machine is principally intended for teaching young children who have not yet learned to read, adults and children of subnormal intelligence and those under certain forms of physical handicap." (Behavioural Research and Development Ltd., 1968).

It had several attributes:

"very simple to operate .... creates stimulating environment ... holds interest of the student ... infinitely patient ... encourages speech ... (<u>ibid.</u>) and was:

"currently being used by educational centres for subnormal children." (<u>ibid.</u>)

The machine was then priced at £500.00, programmes of 100 slides at £25.00. When, in 1971, a solid-state version of the machine was marketed by the same firm, priced at £650.00, the same blurb was re-issued.

Despite the price, the machine seemed to have an immediate appeal to some of those bodies concerned with educational provision for the severely subnormal, most notably the Parents' Societies affiliated to the National Society for Mentally Handicapped Children. Some of these local Societies contemplated buying Touch Tutors for use in their local Training Centres and some in fact did but machines. A television programme appealed for money - and bought two machines.

Despitee, therefore, the cost of the machine it was being considered for everyday educational use with severely subnormal children. Was there the theoretical or empirical evidence to justify such use? For although the Touch Tutor could not be said to be detrimental, neither was there evidence for its educational value equalling its cost.

(5) <u>The justification for the use of the Touch Tutor with S.S.N. children</u>.

The discussion so far has been considering five points of information in relation to the use of teaching machines with the S.S.N. since it was argued, in Chapter 1, that these five points represented important pre-requisites in order for the wider educational use of a machine like the Touch Tutor to be worthwhile. Having considered evidence on these five points in relation to previous studies with machines of similar design it is now necessary to consider them in re ation to the Touch Tutor itself.

<u>Point 1</u>: The Touch Tutor is clearly a machine appropriate to the aims of Skinner, in the same way that many of the previous machines we have discussed have been.

<u>Point 2</u>: There is evidence from the two studies cited of the Touch Tutor's use with pre-school and S.S.N. children that the machine is attractive to such children, in that groups of them have worked at the machine over a number of sessions with the spoken reinforcement of the machine as a reward. We do not know, however, how representative such a finding is for S.S.N. children in general.

<u>Point 3</u>: 12 of the 16 children studied by Harper <u>et al</u>. (1971) learned to match to sample to a criterion of 90% correct

with the remaining children developing incorrect patterns of response, in up to 10 sessions lasting approximately 20 minutes each. Again, we do not know how representative this sample of children may be. In the study of Huskisson et al. (1969) 17 out of 18 pre-school children reached criterion in an unspecified number of sessions.

Point 4 : There has been no discussion of the use of the Touch Tutor by the teacher. The Touch Tutor is, however, a portable device not requiring semi-permanent location for its operation and physical accommodation.

Point 5 : Little has been said about the extent to which the Touch Tutor should teach the S.S.N. child. The studies of the machine cited in this Chapter have shown that the machine may teach children to match to sample on easily discriminable stimuli but it was found that the matching of all but three children broke down on difficult stimuli.

The fact that little detail has been provided by these studies of the responses of many S.S.N. children to the Touch Tutor, coupled with the fact that a similar fault is present in the studies discussed in previous Chapters makes it difficult to say, at this stage, how far the Touch Tutor presents similar problems in its use that have appeared in those studies. The machine is, however, fundamentally similar in mode of operation and in the main characteristics of the responses of children to it to those previous machines.

We may, therefore, expect that S.S.N. children in general would find the machine attractive and would respond to it; that, however, fewer children than these would be able to perform the matching to sample task correctly; that some would respond to instructions designed to emphasize the essential nature of the task. Moreover, some children not learning to match to sample would develop incorrect patterns of response. What cannot be predicted with any exactness is the numbers of children who would respond in these various ways to the machine, whether the machine may be used in classrooms for the S.S.N. child by the teacher, nor what the machine may be used to teach. In addition, little is known about the nature of the incorrect patterns of response which have so frequently been mentioned by previous authors and which, receiving little attention, have been generally attributed to 'faults' in procedure.

The aim of the following Chapters is to provide further information on these problems in the hope that further light may be thrown on them.

CHAPTER 5 : EXPLORATORY STUDIES WITH THE 'TOUCH TUTOR AND "EXPERIMENT 1".

(1) Exploratory Studies

In the initial stages of the research the Touch Tutor was taken to a local subnormality hospital to study some of the reactions of the children in the hospital school to it. Of the 62 children in the school 17 were selected to represent a cross section in ability of those children the teachers believed would show any response to the machine at all. Some of the children in the school had been seen by a psychologist with a view to gaining some measure of their I.Q. or M.A. but only 6 of the 17 children had been given a numerical estimate based on a standard test. These 6 children had I.Q.'s on the W.I.S.C. of from 45 to 60 and one had been given an I.Q. of 41 on the W.P.P.S.I. The work of Bland can, however, be used as an additional guide here: his survey of Hospital Schools suggested that just under half of the children in such a school would have an I.Q. of 30 and below and just under half would have an I.Q. of between 30 and 55, in the 'typical' hospital school (Bland, 1968). The remaining children would have I.Q.'s above 55. One would expect that this group of 17 children would contain fewer profoundly retarded children than occur in the typical hospital school, since children whom the teachers regarded as unlikely to respond to the machine at all were not included in the group. Individual details of the children used are given in Appendix 1.

The Touch Tutor, due to lack of facilities, was initially placed on a table in the school 'office', situated between the children's classrooms. Children were brought individually to the room by one experimenter (Dr.N.A.Beasley), who knew them, and seated in front of the machine which displayed one of the slides in the makers' "-2" programme. This programme consisted of 100 slides which could be recirculated, depicting colours, shapes, pictures, and picture-word combinations. In 20 of the slides two of the response panels were blank (these were termed "one-choice" slides), in 20 one panel was blank ("two-choice" slides), and in the remaining 60 all three panels contained stimuli ("three-choice" slides).

Initially children were given no instructions, as in the study of Harper et al. (1971). Unfortunately, the children made no responses to the stimulus panels unless prompted, and it seemed preferable to follow the method of other workers - that is, to give the child some kind of demonstration of the machine's mode of operation. Subsequently, therefore, children were given demonstrations of how the machine worked, together with various explanations, encouragements and prompts in a general manner suggested by the introductory procedures of Fellows and Bijou and by the conclusions of other relevant studies (see Chapters 2 & 3). Even so, many children responded incorrectly to the machine (although a number quickly learned to match to sample), systematically touching all the response panels in turn, randomly exploring the front of the machine, or continuing to touch the response panels until the slide had changed, even though the Touch Tutor had named the stimulus object.

Turning to the literature describing previous studies in an attempt to find an explanation for the development of these incorrect response patterns, it seemed that blame had commonly been laid upon unintended reinforcement contingencies arising from the mode of operation of the machine, in conjunction with the Subject finding difficulty in the programme material (Hively, 1960, 1962; Bijou, 1968; Sidman and Stoddard, 1967). These explanations seemed plausible, and they suggested that if one could determine what these contingencies were, and if one could make the final matching task easier for the children, these difficulties might be resolved.

Watching the children working upon the machine, two features of their behaviour were striking. One was the habit of some of them to touch the panels of the machine repeatedly until the slide changed, even when they had responded and had heard the machine speak. The other was their successful performance on the one-choice slides in comparison to their unsuccessful performance on the two- and three-choice (matching to sample) slides.

The first of these observations suggested the possibility of the children actually finding the slide change a more rewarding event than the machine speaking. If this were in fact so children would be unlikely to learn from the machine since they would be reinforced equally for correct and incorrect responses. It was possible, therefore, that a reinforcement condition in which a correct response was immediately followed by a slide change, and incorrect responses were not detected by the machine, would teach matching to sample more effectively to the child.

The second observation was reminiscent of the wide use of 'fading' in previous experiments. Perhaps allowing children to work on one-choice, two-choice, and three-choice slides, in that order, would improve matching.

The possibility that these changes in machine and programme design might affect matching ability was increased as work continued with these 17 children on lines suggested by these observations and hypotheses. The makers' programme was re-arranged into blocks of one-choice, two-choice, and three-choice slides, and moving the slide immediately on after a correct response was made and keeping it still after an incorrect response was tried. It did seem that, as a result of these changes, children were more correct in their responding (and, to a certain degree, more 'enthusiastic').

By the end of this exploratory study two of the children had had three sessions with the machine, nine had had two sessions and six had had one session. The time the children had worked with the machine in any one session ranged from 2 to 30 minutes, with the median being around 10 minutes. The performance of 7 of the children on "three-choice" slides was above chance responding, with 6 of these children having attained this standard in their first session and one in her second session. Three children matched the majority of one- and two-choice slides correctly but made errors on many of the three-choice slides. Four children were able only to respond correctly to one-choice slides, and three children made no responses to the machine at all. Although some children had received training under different conditions the numbers in each were too small to permit any conclusions to be drawn about the effectiveness of the different teaching conditions - other than the general ones outlined above.

These initial studies did not form a systematic investigation but were invaluable as a general observation of how children responded to the machine. What they had done was to give the general impression that the range of ability, in relation to the Touch Tutor in this hospital school, ranged from accurate and consistent matching, through one-choice 'matching', through disorganized responding to the touch panels, down to no responding. They had also suggested two remedial measures for those of the children who responded correctly to the "one-choice" slides only. What the study had not done was to give any accurate idea of the numbers of children who fell into these categories in the hospital school as a whole, nor of the exact effect of the two possible changes in the machine and programme material upon matching to sample behaviour. Since it was this kind of information which was necessary for the present evaluation of the Touch Tutor's use it was decided to repeat these early studies on a more formal basis - that is, under more controlled conditions, and with a more complete sample of children.

(2) The First Main Study ("Experiment 1")

(i) Introduction

In line with the above discussion and with the plan of Evaluation outlined in the first chapter of this work the study had three broad aims. The first was to determine the extent to which a cross-section of S.S.N. children (represented in this case by children from a local subnormality hospital school) found the Touch Tutor attractive and were able to use it. The second was to evaluate the importance of two changes (one in programme design and one in the machine's mode of operation) in the Touch Tutor upon the extent to which children were able to use the machine (that, is to match to sample on it). The third aim was to determine and discuss general problems which arose from the Touch Tutor's use with these children during the study.

(ii) Method

(a) Subjects

52 of the 62 children on the register of the School of a local subnormality hospital acted as subjects. 10 children who came mostly from the 'infant' class of the school were not tested for administrative reasons.

The chronological ages of the sample as a whole ranged from 7 to 19 years, with the median being around 13 years. No M.A. or I.Q. data were obtainable for the sample as a whole, but an indication of these can be obtained from Bland's work (see above). Estimates of the I.Q.'s of 13 children were obtained from the results of the Stanford-Binet, W.I.S.C. or W.P.P.S.I. tests and these ranged from approximately 11 to 60. Translating these into Mental Ages by taking test results and chronological ages into account, 12 children had mental ages of above 4 years 6 months at the time, approximately, they worked with the Touch Tutor. The median mental age of the sample, using Bland's figures and a knowledge of the median chronological age of the sample was 3 years 11 months. These figures are very rough estimates, but they may serve as a general guide to the composition of the sample in these terms. Some specific details of the sample's composition are given in Appendix 1.

The children were from the hospital school used during the initial studies and the 52 children studied in the present study included 16 of the children who had taken part in the initial studies. Apart from this none of the children had previously taken part in an experiment.

(b) Experimental Design

The aim of the experiment was to compare the responses of children under two main conditions. One condition concerned the arrangement of the subject matter into blocks of slides arranged progressively in order of difficulty in contrast to mixing these randomly throughout the programme. The other concerned the operation of the machine in its normal manner in contrast to its moving to a new slide immediately a correct response had been made and remaining still after an incorrect response. Here there were two factors, which each had two levels. It will be convenient to refer to them respectively as the 'Progressive' and 'Mixed' teaching conditions and the 'Sound' and 'No Sound' teaching conditions. The possibility that an interaction of these two factors could be important suggested that four experimental conditions should be created from these factors, which gave rise to a 2 x 2 experimental design.

The heterogeneity of the children in this subnormality hospital school, coupled with the relatively small numbers, suggested that four matched experimental groups of subjects should be created. To offset this was the lack of data upon which matching could be based. The children were therefore assigned at random to the four teaching conditions.

Although there is evidence that children require up to 10 sessions in order to acquire the principle of matching to sample (Harper et al., 1971) the children in that experiment were given no instructions, indicating that fewer sessions might give rise to similar results, if appropriate instructions were used. The studies previously discussed in this volume in Chapters 2 and 3 and the study of Weinstein (1941)[(1)] suggested that appropriate instructions would probably involve drawing the child's attention to the need to look at the top stimulus panel before looking at the lower, response panels of the machine, since not doing this seemed to be an important concomitant behaviour of children not matching to sample, as well as showing the child that some comparison of the stimuli present on the screen was necessary for gaining reinforcement. There was also the possibility that children working on a teaching machine requiring them to match to sample could, if they were responding incorrectly, develop patterns of responding which continued practice not only might not cure, but might encourage (Hively, 1960; Sidman and Stoddard, 1967). It was, therefore, resolved to limit the number of training sessions each child would have with the Touch Tutor. This was set at two sessions when it appeared, as the study proceeded, that the effects of the training conditions on the children's behaviour were slight.

Allied to this consideration of the number of training sessions each child should receive was a consideration of how the effects of their experience with the machine should be gauged. It was hoped that an ongoing measure of their behaviour could be devised but the failure of the recording instrument used (an event recorder) accurately to measure the number of correct responses children made, made it subsequently necessary to assess the performance of children by screening tests. Thus, all children received what amounted to a Pre-test and a Post-test of their performance during the study and these provided measures of the effectiveness of the experimental manipulations and of the study as a whole.

(c) <u>The 'Touch Tutor'</u>

The Touch Tutor required modifications for the study to enable an evaluation to be made of the effectiveness of the slides changing immediately after a correct response had been made upon the children's behaviour to the machine. The control mechanism of the machine was,

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(1) Weinstein (1941) made detailed study of the development of matching to sample in two rhesus monkeys and in two children of normal ability aged approximately three years. Realising that looking at the sample stimulus was vital to the mastery of the task he took pains to establish this aspect of behaviour in his four subjects. The 'preliminary tutoring' this required was, however, extensive; the two monkeys required respectively 1199 and 1584 trials before they were systematically matching and the children approximately 1000 each. In a later study (1945), involving the filming of monkeys while matching, it seemed that efficient performance was marked by a glance at the sample stimulus, followed by rapid examination of the response stimuli, before the choice finally was made.

therefore, changed so that any correct response to the stimuli would result in the immediate changing of the slide and any incorrect response would have no result (i.e. the slide would remain on display). No verbal message occurred during this 'No Sound' condition.

(d) The Experimental Laboratory

The hospital authorities could not provide a room for the duration of the study in which the Touch Tutor could be semi-permanently located. This was an essential requirement, in order that the conditions of the experiment could be standardized for all children. After some consideration of the possible alternatives, a proposal was submitted to the "Joseph Rowntree Memorial Trust" for finance to purchase a 'Mobile Laboratory' for the study. The Trust kindly agreed to the proposal and a Ford 'Transit' Parcel Van was accordingly purchased and modified for use as such a laboratory (see Figure 5.1). The interior of the van was divided into two compartments (see Figure 5.2) one of which (the child's compartment) appeared as an attractively furnished 'room', while the other (the experimenter's compartment) housed the various control and recording apparatus. The Touch Tutor was located with the display screen on the child's side of the dividing partition and the rear of the machine on the experimenter's side. A small one-way mirror was located above and behind the child on his left as he sat in front of the machine.

(e) Programme Materials

In the exploratory studies it had appeared that the schematic rendering of the pictures in the Cleary and Packham "-2" teaching programme was causing confusion to some children. In addition the numbers of one-choice, two-choice, and three-choice slides were unequal, making those slides unsuitable for a controlled study. Accordingly a series of line-drawn black and white slides of simple objects (house, clock, car, man, hand, and chair) were prepared in different ways for use in the teaching conditions (see Figure 5.3). Equal numbers of one-choice, two-choice, and three-choice slides were loaded into slide magazines either randomly (for the 'Mixed' teaching conditions) or in three blocks in that order (for the 'Progressive' teaching conditions). In the 'No Sound' teaching condition 100 slides of each choice type were prepared for the 'Progressive' condition; in the 'Sound' teaching condition 33 of each choice type were prepared for the 'Progressive' condition. This discrepancy occurred because

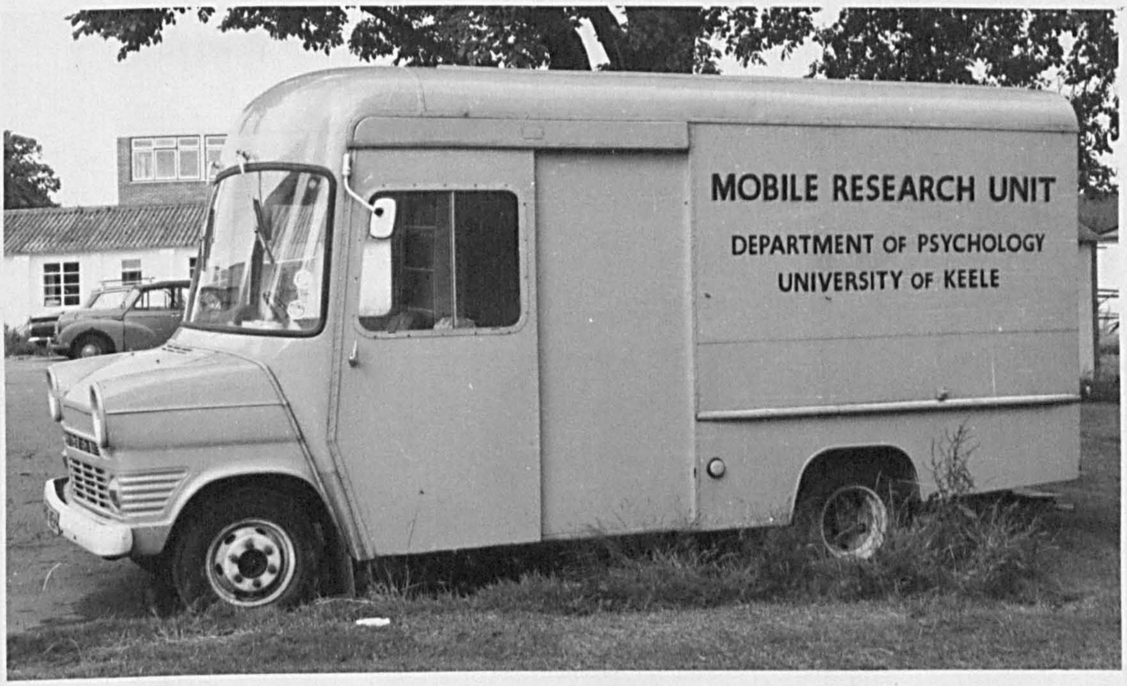

Figure 5.1

Exterior of the Ford 'Transit' Parcel van used as the 'Mobile Laboratory'.

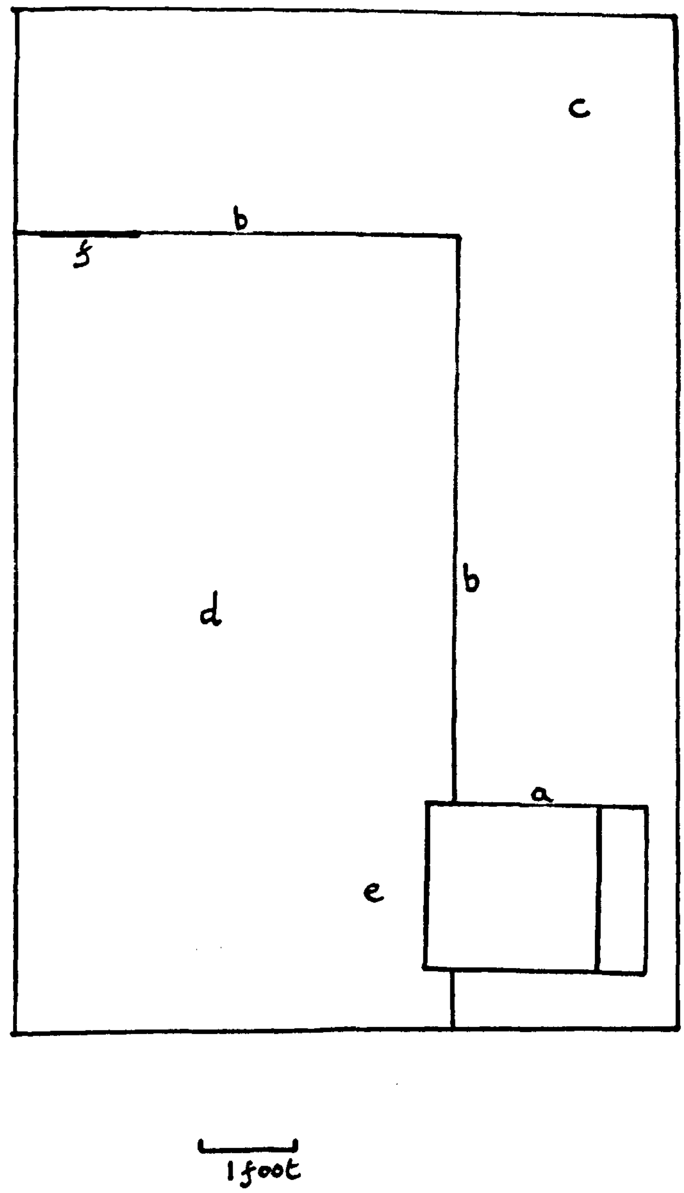

Figure 5.2

Plan of the interior of the Mobile Laboratory showing the Touch Tutor ('a') located in the screen ('b') dividing the laboratory into areas for the experimenter ('c') and for the child ('d'). The position of the child's seat can be seen at 'e' and the one-way mirror at 'f'.

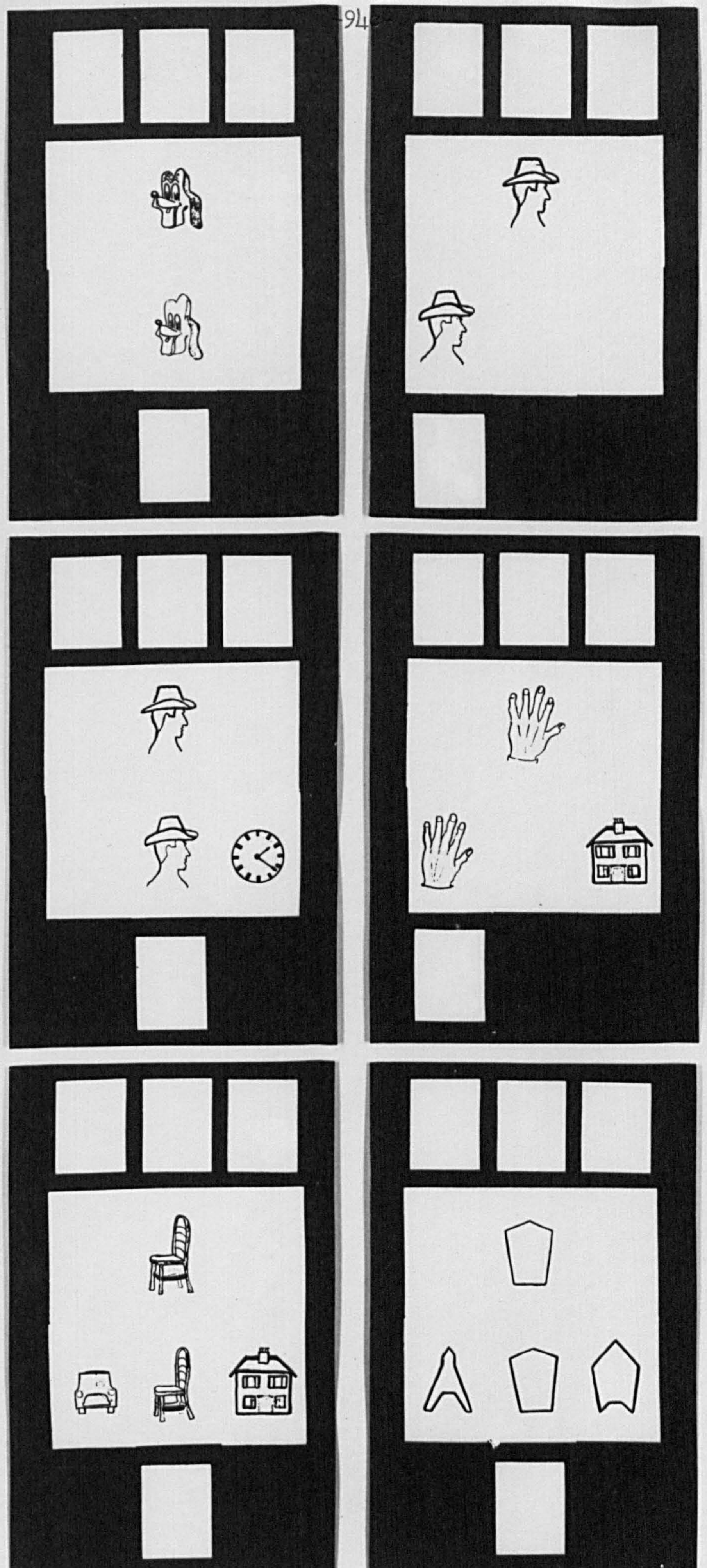

Figure 5.3: Examples of the stimuli used in Experiment 5 in one-choice, two-choice and three-choice format.

a correct response plus a slide-change took two seconds in the 'No Sound' condition and six and a half seconds in the 'Sound' condition and some equalization of the number of slides the child experienced was required.

(f) <u>Introducing children to the Experiment</u>

In the initial study it had appeared that some kind of instruction in the operation of the machine was preferable to allowing children to discover how to operate it completely by themselves. This belief had been reinforced by the fact that all other studies than that of Harper <u>et</u> <u>al</u>. (<u>op</u>. <u>cit</u>.) used some kind of introductory or instruction procedure. In that initial study the introductory method chosen had been an eclectic one, based on a combination of explanations, encouragements, prompts and demonstrations as dictated by the initial responses of the children to the machine. The aim of these procedures had been to draw the children's attention to the important features of the machine's mode of operation which were necessary to its mastery. These, derived from the work of Hively, Bijou and Fellows, related to the need to look at the top panel of the machine before looking at the bottom panels, and to the need for the child to realize that he had to perform some comparison of the stimuli in order to 'make the machine speak'.

However, although this procedure was successful for some children, it was not so for many of them; in the planning, therefore, of this first main study, it was asked whether changes in the procedure should be made. In order to facilitate subsequent understanding of what had happened in this main study it was decided to adopt a standard introductory procedure for all children; the one chosen would have to include an indication of the two main 'features' of the task indicated above and would have to have a reasonable chance of success. In the initial study one useful device had seemed to be <u>pointing</u> to the top panel of the machine before the bottom one and encouraging the child to do the same, coupled with exhortations to 'make the machine speak'. It had seemed preferable to the predominantly verbal method of Fellows (1968) at the time, both because Fellows had had little success with his method with younger children (below M.A. $4\frac{1}{2}$ years), and because S.S.N. children are said to suffer deficiencies, in comparison to normal children, in their verbal comprehension, particularly those in subnormality hospitals (c/f Lyle, 1959; 1960a; 1960b). One other potential value in the 'pointing' method lay in the possibility that the child might remember to do this for every slide thus drawing his attention continually to the need to look at the top slide before the lower ones (Bijou's machine, it will be remembered, did not require the child to remember to do this, it's break-down of the task forced him to do it).

In this study, therefore, each child received an introductory demonstration of the mode of operation of the machine in which the Experimenter (E.) pointed first to the top, stimulus panel, of the Touch Tutor and then to the correct matching bottom stimulus, encouraged the child to do this for himself, and exhorted him to 'make the machine speak'. The exact procedure was as follows:

E. seated the child in front of the Touch Tutor and said "Now ... (name). Watch me". He then pointed slowly and distinctly first to the top and then to the correct bottom panel for each of ten one-choice slides (teaching the child to touch the top and then the bottom pictures was thought to be easier if the child did not have to pay attention to the difference between the pictures as would be the case if two - or three - choice slides had been used); the child could then complete ten similar slides himself. E. did not correct the child if he responded incorrectly, but added "Go on - make the machine speak" at intervals, throughout these latter ten slides.

In line with the aim of providing controlled conditions in this experiment, in order better to evaluate the effect of the different parts of the study, children were given this introduction as a standard procedure. The only departure from it occurred if a child did not respond after the demonstration, when it was repeated, or if a child did not begin to respond himself at the start of his second session, when it was repeated.

(g) Procedure

The Procedure of the study can conveniently be divided into three stages: The 'Introductory and Pre-test', 'Training', and 'Post-test' stages. The Touch Tutor, throughout the study, was situated in the Mobile Laboratory, to which only two children (who are included in the sample of 52) actively refused to come. One experimenter always sat with the child, behind him and to one side, while the other (if he were there) sat behind the screen for purposes of recording, observation and machine operation (Dr.N.A.Beasley sat with the children for half of the study, with J. R. Hegarty behind the screen; in the second half of the study Dr.N.A.Beasley was not often present, when J. R. Hegarty sat with the children in addition to operating the apparatus).

At the beginning of each session a child was brought from his school classroom to the Mobile Laboratory and seated in front of the Touch Tutor. In the 'Introductory' stage E. performed the sequence of instructions described earlier; said, "Now you do it by yourself", and allowed the child to complete ten identical one-choice slides on his own. These twenty slides were all of the same object, a cartoon figure of a dog drawn in black and white. The position of the lower figure in these slides varied randomly between the three lower positions.

On completion of the twenty introductory slides, the child worked through ten slides depicting the six black and white line-drawn figures (house, car, clock, hand, man, chair), all of which contained three response choices. The position of the correct response varied randomly, as it did in all the slides used. In addition, no picture occurred in the same position on more than three consecutive slides and no position was correct on more than three consecutive slides. The child's performance on the ten one-choice and the ten three-choice slides in this 'Introductory and Pre-test Stage' was used as a'Pre-test' record for the child.

In the 'Training' Stage the child was given two sessions of training, in which he worked through one of the four teaching conditions. At the beginning of Session 1 he received his 'Introductory and Pre-Test' slides, at the beginning of Session 2 he was given instructions only if he did not immediately respond to the machine, and in Session 3 he received the 'Post-test' slides (see below).

In the 'Post-test' Stage each child worked through 40 slides consisting of 10 one-choice, 10 two-choice, and 10 three-choice slides in that order, showing the same material as in the 'Training' Stage, and 10 three-choice slides depicting 'nonsense shapes' (Attneave, 1957) which acted as a test of transfer to complex and unfamiliar matching to sample material. The machine in this 'Post-test' Stage was in the same mode of operation as in the 'Training' Stage for each child.

Occasionally, children would cease responding to the Touch panels or would look away while continuing to respond. E., in such cases, generally waited three minutes before giving a verbal prompt to the child, namely "Touch the pictures and make it speak" (or, "Touch the pictures and make it go on" - in the "No Sound" conditions). If no, or only one or two, responses were made thereafter the same 'prompt' would be repeated. If this second 'prompt' had no effect the session would be discontinued. If children persisted in responding after a 'prompt' for more than three responses and then ceased responding the 'prompt' would again be repeated and the session discontinued when responding again ceased. Sessions were generally brought to a close after twenty minutes had elapsed from the time of entering the Laboratory, unless cessation of responding made this time shorter. Some children were allowed to remain slightly longer than twenty minutes, depending on their enthusiasm for the machine. This was done to give a broader picture of the machine's attractiveness to these children.

The Experiment lasted approximately four months, occupying the months of October, November, January and February, 1969-1970. During this period children were studied over periods of about one month but this was not equally regular for all children.

(iii) Results

The Results of the Study and the subsequent Discussion will be presented in relation to the three aims of the study (see page 91).

The task of the first section of results will be to provide preliminary information on the two important points of the First Aim, namely, determining the extent to which a cross-section of S.S.N. children: (a) found the Touch Tutor 'attractive' and, (b) were able to use it.

(a) The Touch Tutor's "attractiveness"

As the study proceeded it seemed that a large number of children were not attracted to the Touch Tutor in that they made either no, or only one or two, responses to it before either moving to something else in the Mobile Laboratory or sitting listlessly at the Touch Tutor. Prompts given to these children typically had little effect, or led them to make only one or two further responses. The remaining children were characterized by longer periods of responding to the machine, giving the general impression of having greater interest in it. This was not a simple, constant effect, however, as the responsiveness of some children changed between the different Stages of the study. Putting these general impressions on a provisional numerical basis, 37 children completed at least 8 slides unaided during at least one of the three Stages ('Pre-test', 'Training', and 'Post-test') of the study, of whom 27 completed at least 8 slides during every stage.

Thus, using the criterion of making at least 8 unaided responses to the Touch Tutor as the minimum for finding the Touch Tutor at all 'attractive', 15 children in the sample found no interest in the machine, while a further 10 did not consistently respond during every part of the study.

Table 5.1 shows further details of these results by giving, in the main body of the Table, the numbers of children who responded to at least 8 slides in each of the various sections of the 'Post-test' (each section comprised 10 slides of a particular choice type). In brackets are given the numbers of children who showed a decrease (indicated by a minus sign) and the numbers who showed an increase (indicated by a plus sign) in responding from the two sections of the Pre-test. The reader will observe that the numbers of children in each of the four experimental groups are uneven; this is due to the fact that the 10 children not tested in the Study became unavailable after the Study had begun. In considering the Table it should be borne in mind that no instance occurred of a child responding more frequently to slides of a more complex kind than to slides of a simpler kind, at any stage of the Study, and that no instance occurred of a child responding in the 'Training' stage who did not also respond in his 'Pre-test' stage.

Table 5.1

Numbers of children completing at least 8 slides during the sections of the 'Post-test' (and of the 'Pre-test') stage of the Study.

Experimental Condition		Type of Slide			
		'One-choice'	'Two-choice'	'Three-choice'	'Nonsense'
"No Sound"					
"Mixed"	n = 14	10 $\binom{+2}{-0}$	7	7 $\binom{+0}{-1}$	5
"Progressive"	n = 14	9 $\binom{+1}{-2}$	7	6 $\binom{+0}{-3}$	5
"Sound"					
"Mixed"	n = 11	7 $\binom{+2}{-0}$	5	5 $\binom{+1}{-0}$	5
"Progressive"	n = 13	7 $\binom{+1}{-2}$	7	7 $\binom{+2}{-2}$	7
All Conditions	n = 52	33 $\binom{+6}{-4}$	26	25 $\binom{+3}{-6}$	22

Table 5.1 shows that, at the end of the Study, 33 children out of the sample of 52 were responding overtly to the Touch Tutor at the criterion used here of having completed at least 8 slides unaided. The numbers of children who responded at this level during the 'Post-test' dropped, with only 25 children completing at least 8 three-choice slides. The effect of the study was not markedly to increase the numbers of children responding to the Touch Tutor; 31 children completed at least 8 one-choice slides during the 'Pre-test', 28 of whom completed at least 8 three-choice slides. In addition, no teaching condition, or combination of them affected responsiveness more than any other; for example, comparing the numbers of children in the 'Pre-test' in the "No Sound Progressive" and in the "Sound Mixed" conditions who completed at least 8 one-choice slides, which seem quite different, on the Fisher Test (Siegel, 1956) the probability of obtaining these two frequencies on the basis of chance is 0.129.

These data give a picture of the point of 'minimum responsiveness' to the Touch Tutor, but little idea of the nature of the 'upper reaches' of responsiveness. To remedy this data are given in Tables 5.2, 5.3 and 5.4 on two main variables for the 37 children in the sample who made at least 8 responses during one stage of the study. Table 5.2 gives information of the total time these children spent in the Mobile Laboratory during the whole of the experiment; Table 5.3 shows the number of slides they completed during this time; Table 5.4 gives a measure of the 'rate of response' of these children by showing the ratios of these two measures.

Table 5.2

Total time in minutes spent in the Mobile Laboratory during all stages of the study by 37 children

Experimental Condition		Time in minutes	
		Mean	S.D.
"No Sound"			
"Mixed"	n = 10	42.80	4.89
"Progressive"	n = 11	41.54	6.40
"Sound"			
"Mixed"	n = 7	46.28	15.40
"Progressive"	n = 9	40.20	15.56
All Conditions	n = 37	42.46	11.25

Table 5.2 shows that children in each experimental group were willing to stay with the Touch Tutor for over 40 minutes during the experiment. It should be remembered that the experimental procedure involved the termination of a session by the experimenter after approximately 20 minutes providing that the child was responding until that time, so that these data do not represent the maximum time children could have worked upon the machine. They do, however, give the reader a numerical indication of the extent of differences between the four experimental groups and of the range of children's responsiveness as measured by this variable. Similar considerations apply to the next set of data.

Table 5.3

Total number of slides completed during all stages of the study by 37 children

Experimental Condition		Number of slides completed Mean	S.D.
"No Sound"			
"Mixed"	n = 10	173.80	103.10
"Progressive"	n = 11	182.54	90.75
"Sound"			
"Mixed"	n = 7	158.57	111.68
"Progressive"	n = 9	193.55	87.55
All Conditions	N = 37	178.32	98.43

Table 5.3 is largely self-explanatory; one important feature is the variability in the number of slides children completed which it reveals. The number of slides completed did, to enhance the clarity of the Table, range from under 60 slides completed to over 290, in each of the experimental groups.

Table 5.4

The mean number of slides completed for each minute spent in the Mobile Laboratory during all stages of the study ('response rate') by 37 children

Experimental Condition		'Response rate' Mean	S.D.
"No Sound"			
"Mixed"	n = 10	4.02	2.41
"Progressive"	n = 11	4.38	2.24
"Sound"			
"Mixed"	n = 7	3.18	2.21
"Progressive"	n = 9	4.80	0.90
All Conditions	n = 37	4.10	1.98

Again, Table 5.4 is self-explanatory. As in the previous Tables, the similarity between the four experimental conditions is apparent, with children in each responding at a similar average rate. This is interesting not only because it was thought that the experimental manipulations might have some 'psychological' effect on the children but also because there is a marked physical difference between the 'No Sound' and 'Sound' conditions in terms of the number of slides per minute it was possible to complete. A child responding completely correctly in the 'No Sound' condition could complete at least three times the number of slides than could a child working in the 'Sound' condition, due to the length of time the machine took to change slides in the two conditions.

It is impossible at this stage to say that these Tables show that children, for example, responded 'well' or 'at a high rate', because we have no numerical criterion on which to base such a judgement. Therefore we can only use the above data as a means of describing, numerically, the children's responsiveness during the study, and, of course, for comparing the effects of the four experimental conditions. However, it is possible to brighten the rather sparse numerical picture so far created by some more personal observations of how the children responded. Thus, some children were extremely enthusiastic about the machine, showing obvious pleasure when it moved or spoke. Others responded more seriously indicating intense concentration by responding steadily to the machine and not engaging in any 'extraneous activities'. Other children responded to it, but seemed to prefer to talk to E. (although this was not encouraged), to look out of the window, or to leave the Mobile Laboratory. Many children, finally, sat listlessly staring at the Machine, or played with some part of it which was not related to the Touch panel area - such as the speaker grille or the aluminium surrounds to the Touch panels.

(b) The extent of correct responding (matching to sample).

A 'correct response' on the Touch Tutor (or, 'matching to sample') is defined as a response to the matching stimulus which is the first response to the lower, response panels made after the appearance of a slide. Whether before this a child responds or does not respond to the Top panel of the Touch Tutor, or after it to other response panels, is immaterial, as far as the present definition of a 'correct' response goes.(1)

Few children were matching to sample at the beginning of the study and few more were doing so by the end. Table 5.5 shows this by indicating the number of children in the 'Post-test' who responded correctly to at least 8 slides of each choice type. The form of the Table is identical to that of Table 5.1; in brackets are shown the numbers of children who showed a decrease and those who showed an increase in the correctness of responding between the 'Pre-test' and the 'Post-test'. The children who were shown

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(1) One must also consider what is to be taken as evidence of 'above-chance' responding. On tests in which all slides contain the same number of response choices a less stringent 'criterion' level may be accepted than upon tests based on mixed one-choice, two-choice and three-choice slides. Thus, the 90% level Cleary & Packham adopted for their slide-sequences may be thought too stringent for the present purposes. On the other hand it is difficult to ensure that children are, in fact, in mastery of the principle of matching if too low a score be used as criterion. The practice adopted here was to use a criterion level of 8 correct responses out of 10, which had a chance probability of 0.006 (calculating on the basis of a correct response having a chance probability ('p') of 0.333 and an incorrect response having a probability ('q') of 0.667). Difficulties arise, however, in the calculation of levels for two- and one-choice slides, particularly for the former. It could be argued that with one blank panel $p = q = 0.500$, rather than $p = 0.333$, $q = 0.667$. In these experiments it was noticed that children did touch lighted, blank panels; therefore, it was felt legitimate to adopt a criterion level of 8/10 slides correct for all types of slide. If, however, a case can be made out for computing on the basis of $p = q = \frac{1}{2}$, 8/10 correct has a probability of 0.055, which approximates the accepted chance level.

in Tables 5.1, 5.2, 5.3 and 5.4 may be assumed to be recorded in Table 5.5; for example, the 25 children in Table 5.5 who responded correctly to one-choice slides in the 'Post-test' are part of the 33 who completed these slides in the 'Post-test'; 8, therefore, responded incorrectly to these slides.

Table 5.5

Numbers of children responding correctly to at least 8 slides during the sections of the 'Post-test' (and of the 'Pre-test') stages of the study.

Experimental Condition		Type of Slide 'One-choice'	'Two-choice'	'Three-choice'	'Nonsense'
"No Sound"					
"Mixed"	n = 14	8 $\binom{+2}{-0}$	1	1 $\binom{+1}{-0}$	0
"Progressive"	n = 14	7 $\binom{+2}{-2}$	3	2 $\binom{+0}{-1}$	0
"Sound"					
"Mixed"	n = 11	4 $\binom{+1}{-0}$	1	2 $\binom{+0}{-0}$	3
"Progressive"	n = 13	6 $\binom{+2}{-2}$	1	2 $\binom{+1}{-1}$	2
All Conditions	52	25 $\binom{+7}{-4}$	6	7 $\binom{+2}{-2}$	5

Table 5.5 shows that the majority of children in the sample could not match to sample even at the end of the study. Rather more children were able to respond correctly to the one-choice slides but nearly half the children could not do even this. Performance was not markedly better on two-choice than on three-choice slides. The nonsense-shape transfer test had a curious effect; two children correctly matched these who had not done so with the previous two- and three-choice slides, while three of the remaining children matched them equally well, and four did worse on these than on previous matching slides. One final point concerning Table 5.5 which should be noted is that no child responded correctly to slides of a more complex choice type than to easier ones, with the exception of the two children noted above, and two children who completed 3-choice but not 2-choice slides correctly.

We shall now turn to a consideration of the second main Aim of the Study, namely determining the effects of the four experimental conditions upon matching to sample.

(c) The effects of the four experimental conditions upon matching to sample.

Inspection of the Tables presented so far will suggest to the reader that the four experimental condtions had a similar effect upon the children's responding (and, although this was not the prime aim of the experimental manipulations, upon the machine's attractiveness as defined by the numerical data so far presented). This suggestion is borne out by statistical analyses of the data represented in the Tables, an example of which has already been given for Table 5.1. Thus, on the Fisher Test there are no differences between the four conditions for the data in Table 5.5 which cannot be attributed to chance variability; similarly, no significant differences exist between the four conditions on the data summarized in Tables 5.2, 5.3 and 5.4 when analyzed by the most sensitive statistical test appropriate to these data - the Kruskal - Wallis One-Way Analysis of Variahce (Siegel, 1956) - χ^2 values of approximately 0.60 are obtained, strongly suggesting that the data obtained under the four conditions are random samples of the same populations. It is also the case, incidentally, that no significant differences exist between the 'Pre- and 'Post-tests' on these measures.

Thus, the study did not substantiate the hypotheses formulated after the Exploratory Studies about the effects of the four teaching conditions. The changes in programme material and in the machine's mode of operation did not help children to respond more correctly (neither did they lead children to respond more enthusiastically). Moreover, the children's experience with the machine did not generally increase either correctness of responding or enthusiasm.

(d) General Problems arising during the Study.

During the study the writer kept note of two facets of the children8s behaviour with respect to the third Aim of the study, although he was unable to keep a detailed record of them. One was the occurrence of some of the systematic, incorrect patterns of responding which were so noticeable in the initial studies, the other was the probable effect of the instruction/introductory procedure on how the children responded to the machine.

It did not seem that the experimental manipulations contributed significantly to the lessening of the incorrect response habits which were present during the initial studies. Throughout the present study it seemed that children not matching to sample were engaging in tendencies to touch all the response panels repeatedly until the slide changed in the "Sound" experimental condition (and an apparently analogous habit of repeatedly touching a panel in the "No Sound" condition which was an incorrect choice, and then moving to touch one of the other panels until the slide changed), even when the machine had spoken; and in tendencies to touch particular positions of the response panel area (such as always the right hand panel) when a new slide appeared, irrespective of the stimuli displayed. While these seemed the most common patterns of response to the Touch Tutor they were not typical of all the children; some children engaged in complex responding which defied understanding after casual observation. Neither were idiosyncratic patterns of response limited only to those children who were responding incorrectly to certain categories of slide - even children correctly matching to sample on two- and three-choice slides differed in what they did after their correct response and in whether they touched the top, stimulus panel.

What was difficult to see (especially in view of the failure of the "No Sound" amendment to eradicate one of these response patterns, that of repeatedly touching the panels until the slide changed) was how these patterns originated, and what determined their form. Moreover, it was difficult to see how they could be overcome. In this respect, knowing the probable effect of the instruction/introductory procedure on the children's responding was of importance since it could well be this that was leading children into these patterns of responding. On the other hand, a more important factor could well be the particular mode of operation of the machine. Unfortunately, it was not possible accurately to tell from the children's responses during the experiment how far the instruction procedure was affecting children's responses. One possibility concerning it, however, did arise. The instruction procedure used to introduce the machine to the children, in consisting of one-choice slides, seemed to be a cognitively simpler task than was the final, matching to sample task. It was perfectly possible that the children were being 'told' "touch all the pictures and make the machine work", which equipped them well for the one-choice slides, but did not equip them for the matching slides, for which they needed to be 'told' - "Touch the pictures which are the same and make the machine work". The fact that some children tendedrepeatedly to touch all the pictures on the two- and three-choice slides after responding in an ordinary fashion to the one-choice slides reinforced this possibility.

The three points raised in this section, viz. incorrect response patterns and their significance, the effect of one-choice instruction and the effect of touching the top panel first in the instruction, remain as unsolved problems at this stage of our study of the Touch Tutor. In the 'Discussion' of this study so far we shall examine them again in order that further light may be thrown on them; for, if the behaviour of the children who responded correctly to one-choice but not to the matching slides could be understood more closely, it is possible that their matching behaviour could be improved and hence the number of children able to use the Touch Tutor increased.

Other general problems arising during the study related to the mechanics of conducting the experiment in the manner intended. The Touch Tutor had bouts of breaking down, necessitating returns home for repairs, or interruptions in the experiment for repair. Children were usually removed to their classroom and brought back later for resumption of their session when this happened. Annoying, too, were temporary bouts of sickness in the hospital which prevented children from having (on occasions) regular training sessions. These types of problems made difficulties for the controlled conduct of an experimental study, but it is not thought that they substantially affected the results of the study. One other problem related to a conflict between whether having a controlled study at all was as valid as adapting training conditions to the apparent needs of the children; it was decided, in this respect, that only fairly controlled conditions would yield data which enabled some measure of repeatability to be gained and that this, in the light of the aims of the present work, was desirable.

(iv) Discussion

The main question arising in relation to the description of the Sample's responsiveness and correctness of responding obtained from the study relates to its accuracy; that is, how far either over- or under-estimates of these two features of responding have been obtained, perhaps as a result of sampling error, perhaps as a result of procedural error.

Sampling error (at least within the Hospital School studied, not insofar as the Hospital School is typical of others) appears to be negligible. 10 children, mostly from an 'infant class', were not studied. At a later date the teacher of these children and the Head teacher were asked independently how they thought these children would have responded to the machine. Their general impression was that they would have probably responded poorly to it, making few or no responses; this judgement seemed to be based upon the children's responsiveness to other educational apparatus which required the child to engage in visuo-motor movements for a period of time. On this evidence the children represented at best a cross-section of ability, which did not affect the overall conclusions as to the numbers of children responding to the Touch Tutor, and at worst reduced these proportionate numbers.

Procedural error affects those children actually studied. The teachers of the children were informally asked whether they thought that the children who had made few or no responses to the machine were usually more co-operative, or responsive. The general impression was that these children seemed to have responded much as they did in the classroom, when typically it was hard to get them to persevere at apparatus which required 'sitting and doing'. More difficult was the teachers' judgement of whether those children who had responded, but only for part of the study, and whether those children who had responded, but incorrectly, to the various slides should have done 'better'. They seemed surprised with the performance of some children; they also thought that perhaps some children should have done better. They were unsure why children should have responded for only part of the study but pointed out that some children were variable in their responsiveness, due to variability in their reaction to drugs, to bouts of 'bad temper', or to no obvious reason. On the whole it was difficult for the teachers to say how far the study was accurate in the results obtained with those children who had responded, particularly in terms of correct matching to sample performance, although their comments seemed to suggest that the estimates were not grossly different from what they would have expected. The writer came to a similar conclusion in the course of spending time subsequently with these children in their classrooms.

This broad conclusion about the accuracy of the studies so far is strengthened (on the variable of matching to sample performance) by Fellows' argument that matching to sample is a cognitively complex task 'which a young child (4-5 years of age) cannot consistently cope with' (1968, p.10). Many of the children in this sample had mental ages below the age of 4 years 6 months which, Fellows argues, is the cut-off point in competency in the task. It is difficult to make precise comparisons with the results of other studies in this respect, but it is noteworthy that the studies of Weinstein (1941) in the teaching of matching to sample to monkeys and to children, and of the studies described earlier in this volume, point to the complexity of the task for the mentally young.

It is similarly difficult to make comparisons between this study and others in terms of the variable of the machine's attractiveness to the children. The main reason for this is the non cross-sectional nature of previous studies with the S.S.N. of their performance in educational tasks. Perhaps, however, judgements of the validity of the present study's results in this respect are not pressing; many of the children did, after all, find the machine attractive enough to make responses to it and to continue to do so for several sessions. We do not, of course, know how long they would continue to do this.

It is not intended that these considerations should be thought to preclude the possibility that other methods of teaching, or combinations of them could have led more children to match to sample, or that other alterations of the machine could have made it more attractive. However, there does not seem any convincing evidence that other procedures than those used here would have measurably greater effect on either matching to sample performance or the extent to which children would find the machine attractive for children in general in such a hospital school. In addition, some of the procedures which have been used (e.g. the 'fading' programme of Hively, and the different machine of Bijou) would entail expensive or time-consuming modifications to programme materials or machine, while the present ones utilize the present machine and are easily usable and adaptable by teachers.

The main question arising in relation to the Second Aim of the Study relates to why there should have been no differences between the four teaching conditions in the children's responses to the Touch Tutor.

It is fairly certain that the 'Progressive' amendment was ineffective because it was <u>insufficiently</u> progressive. That children matched one-choice slides well but did not transfer to two-choice slides shows that the transition from one- to two-choice slides should have been less abrupt. Some kind of carefully 'faded' series of transition slides, such as that used by Hively (1962), could well have been effective in smoothing the transition, although to make an effective series of such slides it would be necessary to know the basis on which children were responding correctly to the one-choice slides (were they, for example, merely touching the two pictures on the screen without observing their nature, or that they were the same?). One other reason for the ineffectiveness of the 'Progressive' amendment for the sample of children working under this condition as a whole was, of course, that it was inappropriate for some of them. It was inappropriate for the children who were already matching correctly, and it was inappropriate in a different way for the children who were not responding correctly to any type of slide.

It is much more difficult to see why the 'No Sound' amendment was ineffective. It had originally been assumed that children were finding the slide change more 'rewarding' than the machine's speaking. Hence, assuming that children learn better under conditions of reward than non-reward they should have learned better when they were rewarded with a slide-change for a correct response than when they were rewarded with the machine speaking. That this hypothesis was not borne out by the data suggests a fault in the reasoning, a fault which may lie in the belief that the reward given by the machine would reinforce necessarily the skills required by the matching to sample task. If, for example, a child began to respond to the machine by touching always the right hand panel upon the appearance of a slide, after he had become accustomed to the fact that the machine usually operated in some way, the arrangement of the position of the correct response alternative on each programme slide would allow him to be reinforced in this pattern of responding on a schedule of reinforcement which has been shown (Ferster and Skinner, 1957) to be resistant to the effects of non-reinforcement (extinction) i.e. a variable ratio schedule. The effects of such a schedule of reinforcement, which gives rise to resistance to extinction, are to maintain a steady rate of response until the delivery of reinforcement. This could explain why children should touch the panels repeatedly until reinforcement occurred and why children should continue to adopt relatively fixed patterns of responding; the Touch Tutor's mode of operation offered no sanction against these and, in fact, served to reinforce these patterns of responding, instead of the 'correct' pattern of response of matching to sample. This would seem to be a reasonable interpretation of the effects of reinforcement upon children not matching to sample; we cannot know the extent to which it is an oversimplification of their behaviour without conducting a more detailed analysis of children's behaviour. The interpretation does, of course, leave some things unexplained - why, for example, children should continue to touch the panels after the machine had spoken in the 'Sound' condition, and why they should develop a habit of touching always the right hand panel on the appearance of a new slide - but discussion of these can be postponed until later.

With relation to the third aim of the study, it appeared that further information in respect of: the probable effects of the Instruction and introductory procedure on the children's responding to the Touch Tutor, and on the particular patterns of incorrect responding which appeared in some of the children, would be desirable. Elucidation of these features of this first Study would seem to be valuable not only because they represent interesting aspects of the children's performance in their own right, but also because further knowledge of these aspects might help increase the effectiveness of the Touch Tutor as a teaching device.

There is reason to suppose that the particular form of the introductory instructions given to the children about the machine in some measure determined the form of their incorrect response patterns over and above the obvious one of (were such instruction completely effective in giving rise to matching to sample immediately) eliminating their appearance. Therefore, a consideration of the effects of these instructions is relevant to a consideration of the response patterns themselves.

Turning now to these, it will be apparent to the reader that such patterns have appeared in many of the studies we have so far discussed in this volume but that they have been afforded little attention. That they appear to be a fundamental feature of some children's behaviour on such machines suggests that they are of great relevance to the children's operation of these machines and, because of this, deserve more detailed attention. Therefore, a brief digression will be made in the present work to encompass these incorrect response patterns, in order that further light may be thrown upon them. Studying them in relation to the effects of the Instruction procedure used in the first Study, two broad problems deserve discussion. Firstly, how far the instruction procedure succeeds in its aim of encouraging correct matching to sample behaviour. Secondly, how far this procedure causes certain incorrect response patterns to arise and to determine their form. In studying these two broad problems, one would hope that some light may be thrown on the possible complexity of these patterns both in and between children, on the nature of their origin, and upon something of their significance in relation to the children's cognitive functioning. Finally, it is possible that study of these patterns could represent an aspect of the wider study of problem solving by S.S.N. children; they would seem to be representative of certain strategies of problem solving apparently ignored by the workers with teaching machines who have noted them so far and who have regarded them as indicative merely of deficiencies in the effectiveness of their teaching procedures. It is, after all, rare in the lives of these children for carefully programmed problems to come their way; more often, the onus is on them to solve problems. An argument may thus be made for greater attention to be paid to the study of problem solving strategies.

(v) Conclusions

The studies of the Touch Tutor in a subnormality hospital school reported in this chapter have enabled a picture to be formed of the ways in which a cross-section of S.S.N. children respond to a matching to sample machine of the Touch Tutor's design. Approximately 71% of the hospital school responded to the Touch Tutor during some part of the studies, while approximately 50% of the children responded to it consistently throughout the study. In some respects, as we have seen, these numbers are meaningless for they reflect an arbitrary numerical measure of the extent to which the children found the machine attractive, and they were obtained during a period of time which for some children may have been too short and for others too long. Nevertheless this kind of data offers the possibility of beginning an evaluation to be made about the usefulness of the Touch Tutor in a hospital school.

Similar considerations apply to the estimates obtained of the numbers of children who could respond correctly to the various types of slides displayed on the machine. After the children's experience with the machine in different modes, approximately 19% of children could match to sample to the required minimum level of performance, indicating that they had mastered the principle of the machine's mode of operation. 29% were able to operate the machine correctly when only pictures requiring no matching to sample were shown and the remaining children responded correctly to no pictures consistently (52%).

As far as could be determined these estimates of the numbers of children finding the Touch Tutor attractive, and able to use it, were reasonably valid. It was not thought that the numbers could markedly be increased by alternative methods, but the possibility of this happening was not precluded.

It did not appear that changing the machine's mode of operation or the way in which the programme slides were arranged, in the ways done in the present study, markedly affected the extent to which children were able to match to sample (or the extent to which they found the machine attractive). Looking at the reasons why these amendments, which had seemed originally to be worthwhile, should have been unsuccessful, it appeared that insufficient account had been taken of the complexity of the matching to sample task and of the children's behaviour-with the result that the amendments were not having any impact upon the behaviours necessary for the successful execution of the task. The reinforcement offered by the Touch Tutor seemed to be interacting with particular response patterns adopted by some of the children so that rather than the skills of matching to sample receiving encouragement, a variety of incorrect patterns of response were apparently being strengthened.

Unsolved problems appeared during the study with respect to the incorrect response patterns adopted by some of the children, and with respect to the effects of the instruction procedure used to introduce children to the machine at the beginning of the study. It was thought that further information on these aspects would enable more informed discussion of them to be made. The value of such discussion could well be that the effectiveness of the Touch Tutor's mode of operation and of the instructions used to introduce children to it could be increased. If this did not occur, such discussion would provide valuable insight into the behaviour of children in what in some ways may be regarded as a 'problem solving' task.

At the end of this first study of the Touch Tutor's use with a cross-section of S.S.N. children it appears that we have obtained a reasonably valid indication of the numbers of children who find the Touch Tutor attractive, and are able to use it, know something of the problems of increasing these numbers, and have an idea of some of the general problems in its use with these children. The most immediate and pressing problem facing us now is not so much a need for research and other aspects of our Evaluation, but rather to clear up some of the problems raised by our studies so far. It would seem that an extension of the present study could be profitable it it were aimed at clarifying the problems relating to instructions and to response patterns which have arisen in the present study. Possible 'spin-off' from such study might well be that a more complete picture of the extent of children's enthusiasm and correct use of the machine could be gained.

In the next two Chapters the study which was conducted on the basis of these considerations will be described ("Experiment 2"), together with a study ("Experiment 3") conducted with a different sample of S.S.N. children as a replication of Experiments 1 and 2. The plan adopted for presenting these studies will be to describe , in Chapter 6, data from both of them which extends the findings of this Chapter in relation to the attractiveness of the Touch Tutor, to ease of matching to sample, and to the problem of teaching matching to sample; and to describe, in Chapter 7, data from the two studies which bears upon the effects of the instruction introductory procedure upon children's responding and upon response patterns. The reason for separating these discussions is that the complexity of the analyses of these two broad aspects of the data fall on two different planes.

CHAPTER 6 : EXTENSIONS TO EXPERIMENT 1 (EXPERIMENTS "2", "2a", and "3".)

(1) Introduction

It was concluded from the results of Experiment 1 that a fair estimate had been gained of the numbers of children who wanted to and were able to use the Touch Tutor and of some of the general features of its use with such children. These estimates were, however, based upon children working with the Touch Tutor over a small number of sessions, upon data obtained after introductory instructions based upon one-choice slides, and upon only one sample of children. This Chapter presents data which is intended to go some way towards reducing these limitations of Experiment 1. Three pieces of experimental work are described in the course of the Chapter. The first ("Experiment 2") concerns the effect, firstly, of continued training (combinations of 'instruction' and 'practice' sessions) with the Touch Tutor upon the responses of children who, in Experiment 1, responded correctly only to one-choice slides and, secondly, the effect of giving these children introductory instructions with one-choice and two-choice slides. A study of young normal children is described here ("Experiment 2a"), having been performed, principally, to clarify the second aspect of Experiment 2 (it provided, also, the possibility of contrasting the responding of S.S.N. children to the Touch Tutor with that of a group of normal children, some of whom were equivalent in matching to sample performance to some of the S.S.N. children; a discussion of the relevant data for this is given in Chapter 7). Experiment 3 is intended as a partial replication of Experiment 1, providing data on the responses of a different sample of S.S.N. children.(1)

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(1) The reader will recall that this Chapter is primarily intended to furnish data which will help to increase the accuracy of the description of children's responding to the Touch Tutor provided by the previous Chapter. Accordingly it is a description of the main features of the data obtained during Experiments 2, 2a, and 3; more detailed consideration of the data from these Experiments will be made in the next Chapter in relation to the problem of 'response patterns'.

(2) Experiment 2

(i) Introduction

The aims of Experiment 2 were broadly similar to those ofExperiment 1; specifically they were, firstly, to consider what changes in the attractiveness of the Touch Tutor to the children and in matching to sample performance might take place over further sessions with the machine and, secondly, to consider whether any change in matching to sample performance might ensue from instruction to the children based upon two-choice, rather than upon one-choice, slides.

(ii) Method

(a) Subjects

14 of the children (one was no longer available, having left the Hospital) who had responded correctly to the one-choice slides in the Post-test of Experiment 1 acted as subjects. Four of them had obtained scores on the W.I.S.C., W.P.P.S.I., or Stanford-Binet tests of intelligence which indicated that their Mental Ages were above 4½ years; the remaining children had either achieved scores putting their Mental Ages well below 4½ years or had performed in such a way on these tests that measures of their Mental Ages from them had not been possible. The Chronological Ages of the 14 children ranged from 11 to 19 years at the time of testing, median 13½ years. This information is given in more detail, for individual children, in Appendix 2.

(b) Experimental Design

The aims of the Experiment included assessing the effect upon matching to sample performance of introducing children to the machine with two-choice rather than with one-choice slides and noting changes in matching to sample and in the 'attractiveness' of the machine which might take place over an extended period of experience with it. A design which would provide information upon these problems was one in which two groups of children would work upon the Touch Tutor over five sessions, at the beginning of which one group would receive an Introductory procedure in which one-choice slides would be used and in which the other group would receive such a procedure in which two-choice slides would be used. The potential effectiveness of these procedures would be enhanced if each session began with such Introduction.

Accordingly, since the number of children was small, two matched groups of subjects were formed by ranking children in terms of the number of one-choice and two-choice slides they had completed during Experiment 1, forming them into matched pairs, and allocating pair-members randomly to the two experimental groups. The groups were checked for equality in terms of Chronological Age and allocation to previous experimental groups, and were comparable (see Appendix 2).

In the course of the Experiment most children then worked through five sessions (there were unavoidable exceptions) with the Touch Tutor, in each of which each child received twenty 'Introductory' slides comprising either one-choice or two-choice slides, followed by a 'Practice' series of 36 two-choice slides(1) to complete himself.

(c) Touch Tutor, Experimental Laboratory and Programme Materials

No justification was seen for retaining the 'No Sound' mode of operation of the Touch Tutor, since it neither represented the customary mode of operation of the Touch Tutor nor had seemed to cause any fundamental difference to the way children had responded to the machine. The Touch Tutor therefore remained in the 'Sound' mode of operation for the entire Study.

The Mobile Laboratory was again used for the conduct of the studies; the only change in its interior appearance was the removal of the one-way mirror to make room for the camera lens used for the recording of children's responses (see Chapter 7). As far as possible the lens itself was disguised by a black curtain draped around the body of the lens. The videotape recording apparatus was situated in the Experimenter's compartment of the Laboratory. Noise from it was scarcely audible in the child's compartment.

There seemed no reason for changing from the black and white figures used in Experiment 1 and they were retained. Attention to the presentation of the slides was, however, required in order that analysis of the children's response patterns could be made. A full account of the rationale for their presentation is given in Chapter 7;

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(1) The use of two-choice rather than three-choice slides, and the use of a set of 36 slides in each session, were due to the necessity of having explicit conditions for the study of 'response patterns' (see Chapter 7).

suffice it here to note that the slides were prepared in such a way that no known pattern of responding other than correct responding was likely to yield a significantly above- or below-chance score, but that instead of random allocation of response and stimulus positions by random numbers to the slides a pre-determined sequence designed by Fellows (1967) was adopted, with slight modifications.

(d) Instructions to the children

In the 'One-Choice' Instruction condition children received instructions which were similar to those used in Experiment 1. However, the cartoon figure of a dog was replaced by one-choice pictures of the black and white pictures of a man, house, chair, hand, clock and car.

In the 'Two-Choice' Instruction condition children saw twenty two-choice slides in which the centre panel of the response panels was always blanked-off and in which the correct response and incorrect response stimuli were always the same figures, and in the same positions, as on the corresponding number of slide in the 'One-Choice' condition. Slides were, as in the 'One-Choice' condition, arranged in a similar way to those in the sequence of the 36 slides used in the main body of the Experiment with respect to controls for stimulus- and response-preferences.

In both Instruction conditions E. would touch the top and then the correct bottom panel on each slide slowly and distinctly for the first ten slides. In general, his finger would rest on each panel for approximately one second, as in Experiment 1. The exact time was, however, determined (unlike Experiment 1) by the time the machine took to speak, with E. removing his finger from the response panel as the machine began to speak. After these demonstration slides E. allowed children in the 'One-Choice' group to respond alone to ten one-choice slides and took the hand of children in the 'Two-Choice' group, gently guiding their index fingers to the top and correct bottom pictures of each of ten, two-choice slides. The purpose of this was to equate the Groups in terms of the number of reinforcements they had received during the twenty, introductory slides.

At the end of the Instruction period of 20 slides at the beginning of each session, E. said to the children in both Groups: "Now you do it by yourself. Touch the pictures and make it speak." The children were then left to finish the remaining 36 slides by themselves, with E. sitting behind and to the side of them in the Mobile Laboratory, as in Experiment 1.

(e) Procedure

The general procedure of the Experiment was similar to that of Experiment 1. Children were brought to the Mobile Laboratory, given the Instruction procedure and watched by E. while the slides were completed. The main departure from the procedure of Experiment 1 was in the use of Prompts. In Experiment 2 children were allowed only thirty seconds of no responding before a prompt was given, and this was repeated as often as necessary until the 36 slides had been completed. Prompts were always the same: "Go on, touch the pictures and make it speak" and other talking to the children was avoided by E. as much as possible. In general, children worked well, requiring few prompts.

The Experiment was conducted during the months of July, August and September, 1970 - approximately 6 months after the end of Experiment 1.

(iii) Results

(a) General Features

During the course of the Experiment several children became 'ill', an outbreak of dysentery occurred and some children left the hospital. These occurrences, together with holidays, necessitated the uneven administration of experimental sessions and the loss of some children from the Experiment. The effect of these events is to be seen in Table 6.1, which shows subject-losses from the Experiment and the intervals between sessions. Session -numbers relate to actual days; thus Sessions 6 and 7 were days on which subjects were given additional sessions to complete their 'quota' of five. Table 6.1 indicates that only 10 subjects compldted five sessions, one subject having four sessions, two three sessions, one having one session and one completing no sessions.

(b) The Touch Tutor's 'attractiveness'

Children worked well on the Touch Tutor during the Experiment with only one child failing to work on the machine at all. This one child completed no more than two or three slides during the first three sessions and was thereafter 'discontinued'.

Table 6.1

Subject Losses During the Sessions of Experiment 2

Time between Sessions		4 hours	1 week	7 weeks	1 week	1week	1 week
Session	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Subject							
M.W.			drugged & dozy				
J.B.							
V.W.							
P.D.							
J.H.			refused to come to van				
H.H.					very bad temper	ditto	ill
S.E.	over-active & non-co-operative	ditto	ditto	discontinued			
A.E.							
S.H.				left hospital			
M.J.		ill	ill	ill	discontinued		
H.D.							
D.P.							
M.K.							
D.C.							

Table 6.2 gives summary data for the groups of children in terms of the total time children spent working on the machine during the 36 slides of each session they completed alone. The total time spent in the Mobile Laboratory may be fairly accurately estimated by adding 75 seconds (for the initial ten demonstration slides) and either a further 75 for the ten, two-choice slides or 90 seconds (plus or minus about 30 seconds) for the ten, one-choice slides to the times given in the Table. This adds, therefore, approximately three minutes to each child's time for 36 slides, to give the time spent in the Mobile Laboratory during each session.

Table 6.2[1]

Time (in minutes and seconds) taken by children to complete 36 slides during five sessions

Session		1	2	3	4	5	All Sessions
'One-Choice' Instruction.	Mean	6-02	6-18	5-45	5-20	5-09	5-44
	S.D.	1-45	2-04	1-11	0-41	0-31	1-27
	n.	6	6	6	6	5	29
'Two-Choice' Instruction.	Mean	4-53	4-45	5-15	4-55	4-41	4-54
	S.D.	0-37	0-25	1-36	0-37	0-23	0-42
	n.	7	6	6	5	5	29
Both Groups.	Mean	5-24	5-31	5-29	5-09	5-19	5-19
	S.D.	1-24	1-45	1-09	0-41	0-31	1-13
	n.	13	12	12	11	10	58

Table 6.2 indicates the approximately similar length of mean times over the sessions and between Groups with, however, an initial tendency for the 'One-Choice' Instruction Group to have a longer session time than the 'Two-Choice' Group (this does not, however, reach significance; applying the Mann-Whitney Test, 'U' = 11, p. = 0.18 (two-tailed)) and an initially higher variance (F_{max} = 8.05 p. $<$ 0.01). These differences reduce somewhat by Session 5, however, so that both mean times and their associated variances are similar for both groups by this time.

During the Experiment some prompts were given but these were generally few in number. Only two children received more than two prompts in the whole of the Experiment, one received four in his first and only session, and the other receiving three in his second

(1) In this and in subsequent Tables relating to this Experiment the data for Sessions 4, 5 and 6 of the two subjects who missed Session 3 only, have been moved forward one session.

session, eight in his third session and ten in the first 10 (of the series of 36) slides of his fifth session.

It would therefore seem that the Touch Tutor remained attractive to children, in that the majority of those studied were able to continue working with the machine alone over a total period of five sessions of approximately five minutes in length, with no prompts, during which they completed 180 slides. In addition, they each remained with the machine for a period of approximately three minutes of Instruction at the beginning of each session. The fact that no increase either in time or in the number of prompts required by children occurred for the Groups as a whole during the Experiment also suggests that the Touch Tutor remained 'attractive' over the course of the Experiment.

Calculation of the 'response rate' of children is largely unnecessary for these data, since a knowledge of session times is an index of this variable. To aid comparison with Experiment 1, however, it is helpful to know what the response rates were. Table 6.3 shows these by indicating the transformation of the data of Table 6.2 into 'slides completed per minute'.

Table 6.3

Mean number of slides completed in each minute spent working on 36 slides ('response rate') during 5 sessions

Session		1	2	3	4	5	All Sessions
'One-	Mean	6.39	6.28	6.53	6.86	7.06	6.61
Choice'	S.D.	1.50	1.72	1.30	0.87	0.74	1.33
Instruction	n	6	6	6	6	5	29
'Two-	Mean	7.49	7.65	7.08	7.42	7.75	7.47
Choice'	S.D.	0.89	0.64	1.14	0.82	0.58	0.88
Instruction	n	7	6	6	5	5	29
Both	Mean	6.98	6.96	6.81	7.11	7.40	7.04
Groups	S.D.	1.34	1.47	1.25	0.89	0.75	1.21
	n	13	12	12	11	10	58

These data represent a high rate of responding, both in comparison to the mean rates of Experiment 1 and in relation to the mode of operation of the machine. With respect to the latter, it is necessary to remember that the absolute maximum number of slides which it is possible to complete in a minute is approximately nine(1). A child completing 7 in a minute is only using approximately 2 seconds per slide for 'decision time', some of which would (hopefully) be involved in responding overtly to the upper stimulus panel of the machine. A high response rate can, however, be misleading; the children with the highest mean response rates over the five sessions (8.42 and 8.36) were vastly different in their manner of responding to the machine. Whereas the latter responded quickly and systematically in the manner demonstrated by E., the former repeatedly touched the right hand panel of the machine, tapping it with his finger whenever the machine did not speak.

(c) <u>The Extent of correct responding ('matching to sample')</u>

Table 6.4 indicates the number of slides correctly completed by individual children during the first ten slides (slides '21 - 30') and the last ten slides (slides '47 - 56') of each session. All children who completed a session in the 'One-Choice' Instruction condition scored at least 8 out of 10 slides correct during the initial Instruction period of that session.

It is apparent that at the beginning of the Experiment 4 children were correctly matching to sample on these two-choice slides, who had not been doing so at the close of Experiment 1. During the Experiment these children maintained this level of performance, although two of them (J.H. and V.W.) did not do this systematically. At the close of the Experiment a further two children (J.B. and P.D.) had reached criterion.

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(1) Assuming that a slide-change takes approximately 6.50 seconds, from the moment the response panels are touched until they once more become sensitive on the next slide.

Table 6.4

Number of slides correctly completed by individual children in the first (21-30) and the last (Slides 47-56) ten slides of five sessions.

Slides:	21-30	47-56	21-30	47-56	21-30	47-56	21-30	47-56	21-30	47-56
One-choice Instruction										
M.W.	4	5	4	5	4	5	4	5	4	5
J.B.	6	6	5	7	8	10	6	8	8	10
V.W.	8	7	9	10	7	7	9	10	10	9
P.D.	4	6	3	7	8	10	10	9	10	10
J.H.	9	9	5	8	10	9	8	9	5	10
H.H.	7	6	6	4	6	5	5	3	-	-
S.E.	-	-	-	-	-	-	-	-	-	-
No. reaching criterion:	2	1	1	2	3	3	3	4	3	4
Two-choice Instruction										
A.E.	10	10	9	9	9	6	9	10	10	10
S.H.	6	6	3	5	7	6	-	-	-	-
M.J.	5	4	-	-	-	-	-	-	-	-
H.D.	6	4	6	4	5	2	6	3	5	7
D.P.	3	5	4	5	3	5	4	5	4	5
M.K.	7	5	6	5	6	5	6	5	6	5
D.C.	10	10	10	10	10	10	10	10	10	10
No. reaching criterion:	2	2	2	2	2	1	2	2	2	2
Total:	4	3	3	4	5	4	5	6	5	6

The combined instruction and practice periods were not effective in promoting correct responding in the remaining children, and there appeared to be no difference between the two conditions of instruction in this effectiveness.

(d) Effects of the two experimental conditions upon matching to sample

We have already seen that there was little difference between the two experimental conditions in the data of Table 6.4. A similar picture emerges from a consideration of the number of slides correctly completed during each session, as Table 6.5 reveals.

Table 6.5

Number of slides correctly completed by children during five sessions

Session		1	2	3	4	5	All Sessions
'One-Choice'	Mean	22.17	22.00	27.00	26.17	29.80	25.28
Instruction	S.D.	3.87	4.65	6.16	7.95	6.24	6.60
	n.	6	6	6	6	5	29
'Two-Choice'	Mean	22.14	23.83	22.50	24.60	25.40	23.55
Instruction	S.D.	8.25	7.99	8.04	8.16	8.28	8.24
	n.	7	6	6	5	5	29

Table 6.5 shows that the two Groups began the Experiment with almost identical numbers of mean slides correctly completed. As the Experiment proceeded, the numbers of slides correctly completed by the 'One-Choice' Group exceeded those of the 'Two-Choice' Group, but this difference was not statistically significant. Thus, the largest difference seems to lie in the data from Session 3; when these data were analysed, however by the Mann-Whitney 'U' Test, the probability of this being due to chance was 0.24 (2 tailed). By Session 5 the difference had lessened between the two Groups; these data gave rise to a 'U' of 11 (p. = 0.84, 2 tailed).

The variances of the data of the two groups show a significant difference in Session 1 (F_{max} = 4.54, p. $<$ 0.05) but this difference reduces to non-significance in the remaining sessions, and over all sessions.

(iv) Discussion

Subject-losses were again a problem in this Experiment. To the extent that there remained in the Experiment a number of children matching to sample and a number not matching, there are grounds for supposing that the sample of 10 children who participated in the whole of the Experiment were representative of the sample of 14 who began it; there still remains the possibility, however, that subject losses rendered the task of strict comparison of the two experimental Groups an impossible one to perform.

Measurements of the variable of the Touch Tutor's 'attractiveness' have been extended by this Experiment to supply more detailed information on the responding of children to the Touch Tutor. Children in this Experiment were willing to continue work with the Touch Tutor over a further five short sessions, responding at a high rate both in comparison to the mean rates of Experiment 1 and in comparison to the maximum possible response rate. Only one child showed 'boredom', if one is to judge by the number of prompts needed to maintain responding. Thus, these were generally few in number with only one child requiring them in any number.

As in Experiment 1, it seemed that the experimental manipulations were largely ineffective in controlling matching to sample behaviour, in that no marked changes in the extent of this were apparent either over sessions or between experimental conditions. It is, however, heartening that two children acquired the matching principle in the course of the Experiment and that mastery of the principle had developed in 2 children and a 'good grasp' of it in a further two children, since Experiment 1. Why the experimental manipulations should have been ineffective is difficult to say. Some light may be thrown on the question, however, when the responding of the children in this Experiment is analyzed more fully in Chapter 7. This analysis will reveal the tremendous complexity of the responding of these S.S.N. children to the Touch Tutor and it may be that this complexity is by itself the main reason for the continuing ineffectiveness of single instruction procedures to affect more than a small porportion of children in a hospital school sample such as that from which children have so far been drawn. However, one other consideration which must be made concerns the extent to which subject losses and the prior experimental experience of the subjects could have affected the results. The former of these meant that the original matched composition of the Groups disappeared, while the latter could have rendered the Subjects insensitive to the different conditions of Instruction. These difficulties are particularly important for a consideration of the comparison of 'One-Choice' and 'Two-Choice' Instruction conditions.

(v) Conclusions

This Experiment has shown the Touch Tutor being used over a longer period of time than that occupied by Experiment 1, during which children worked at what appeared to be a 'high' rate of responding and during which the number of children able to use the machine was slightly increased by the use of non-verbal instructions and 'practice'. Still, however, the experimental manipulations of the Experiment did not succeed in establishing matching in some children. The Experiment suggested that 'Two-Choice' Instruction was no more effective in encouraging matching to sample than 'One-Choice' Instruction, but the possibility arose that an invalid comparison had been made.

(3) Experiment 2a

(i) Introduction

This brief Experiment was conducted with the aim of determining, with a 'naïve' sample of children, whether any difference could be seen between 'One-Choice' and 'Two-Choice' Instruction conditions in teaching matching to sample. The Experiment may be seen, therefore, as arising directly out of the problem of subject-losses and the problem of prior experimental experience which arose in Experiment 2.

A group of normal, primary school children were used for the Experiment because they were readily accessible as a relatively large group, of homogeneous ability, because they would possibly have been more susceptible to 'misleading' instructions and because they would provide a helpful contrast to the samples of S.S.N. children in their manner of responding to the Touch Tutor if, as the work of Fellows (op. cit.) suggested, roughly half of them would fail immediately to acquire the principle of matching to sample.

(ii) Method

The general Method of the Experiment was identical to that of Experiment 2, only the composition of the subjects being different.

27 normal primary school children who had attended the first class of a local primary school ('Flaxley' School) for two months at the time of testing were allocated randomly to two experimental groups. Two of these children were absent during part of the Experiment, so that 25 children took part in all stages of it and who thus provided the data upon which the Results are based.

Over a period of 4 days children were allowed to work on the Touch Tutor over one experimental session, during which they received identicaltreatment to the subjects in Experiment 2, with respect to experimental procedure. Children who had not learned to match to sample by the end of their first session were given one further session; in all other respects the Procedure was identical to that of Experiment 2. The Experiment took place during the month of October, 1970.

(iii) Results

(a) General Features

All children responded well to the Touch Tutor showing no lack of enthusiasm for working on it. With regard to correct responding, during the last ten slides of each child's work with the machine, 9 children were not matching to sample at the criterion level of 8 out of 10 slides correct, with strong position habits characterizing their performance. All children in the 'One-Choice' Instruction Group responded correctly, at criterion level, to the one-choice slides. Children given a second session showed essentially no change in performance during the session.

(b) The effect of the two experimental conditions upon matching to sample.

Table 6.6 shows details of the matching to sample performance of the two experimental groups. Both medians and means are used as indicators of central tendency in the Table, since subjects tended to score either 18 or 36 slides correct. It will be remembered that no child showed marked improvement or deterioration in matching performance as the Experiment proceeded.

Table 6.6

Matching to sample in normal children under two conditions of Instruction

	Correct responses in 36 slides during Session 1				
'One-Choice' Instruction	Mean	27.93	Median		34.50
	S.D.	8.07	Q.		8.70
	n.	14			
'Two-Choice' Instruction	Mean	30.64	Median	=	34.00
	S.D.	6.93	Q	=	9.10
	n.	11			

	No. at criterion in Slides 47-56		
	Session 1		Session 2
'One-Choice' Instruction	2c.	8	-
	1c.	6	6
'Two-Choice' Instruction	2c.	8	-
	1c.	3	3

Key: '1c.' = one-choice slides; '2c.' = two-choice slides.
'Q' = Semi-interquartile range.

Table 6.6 indicates that correct responding was approximately equal in these normal children under the two conditions of Instruction both in terms of the number of correct responses made during Session 1 and in terms of the number of children who had reached criterion by the end of Session 1. It will be remembered that little change in performance was apparent during children's second sessions. Application of the Median Test to these data for Session 1 gave rise to $\chi^2 = 0.0015$ (N.S.).

(iv) Discussion and Conclusions

Some doubt as to the validity of the results is raised by the loss of two children (through absence) from the 'Two-Choice' Group. This doubt may be dispelled, however, by considering the two possible effects the behaviour of the children could have had on the results. Either the children could both have scored above the combined median of the two Groups (the basic statistic for the computation of the Median Test) or both could have scored below it. Since approximately equal numbers of children in both Groups achieved scores above and below the combined median, neither of these occurrences would have markedly affected the outcome of the Median Test.

The Experiment would seem to suggest, therefore, that the use of one-choice and two-choice slides as the basis for initial instruction in matching to sample, as they were used in this Experiment, had a similar effect on the number of children matching to sample on the Touch Tutor. The Experiment lends weight to the results of Experiment 2, which also suggested that the two conditions of Instruction were similar in effect.

Before leaving the Experiment it may be valuable to comment briefly upon the responses of these normal children to the Touch Tutor in terms of their similarity to the responses of S.S.N. children on the machine.

In terms of the extent of matching to sample, the normal children were broadly similar to the sample of S.S.N. children studied in Experiments 1 and 2, provided that those S.S.N. children who did not reach criterion upon one-choice slides are excluded from consideration. Thus, at the end of the Experiment, a number of normal children were not matching to sample but were responding correctly to one-choice slides only, just as had occurred (albeit in different proportions of the sample) with the S.S.N. children in Experiments 1 and 2. It is, therefore, possible to imagine the formation of a group of 13 normal children (consisting of 9 children responding correctly to one-choice slides only, and 4 children matching to sample who had been drawn at random from the remaining children) who, in matching to sample performance (i.e. number of correct responses made), would be similar to the children who began Experiment 2.

Although, however, these children would be similar in terms of the extent of correct responding, they would be dissimilar with respect to the complexity of their behaviour. It was noticeable in Experiments 1 and 2 that S.S.N. children tended to show more intra- and inter- subject variability than did the normal children in their responding and that they tended to engage in more complex responding. As an example of the latter, it was noted that the majority of the normal children tended to respond to the Touch Tutor only at the beginning of a slide. Many of the S.S.N. children, however, contined to respond to the panels of the machine until the slide changed. A similar 'complexity' was noticeable in other aspects of responding - such as in patterns of response made to the lower panels on the first response of a slide and to the Top panels of the machine. It is true that such an apparent difference between the two Samples of children could be due to the S.S.N. children's familiarity with the Touch Tutor; as we shall see in Chapter 7, however, similar findings occurred with respect to the sample of S.S.N. children from the 'Redcourt' school, who had not experienced the Touch Tutor before measurements of their responding had been taken.

This difference between the sample of children in terms of the complexity of children's responding is not only interesting per se, but it provides the possibility of playing down the role of Instructions in the creation of response patterns, particularly that pattern noticed in Experiment 1 which involved the touching of all the pictures displayed upon the screen of the Touch Tutor on any one slide. It is possible, therefore, that the exact form of Instructions used may be of less importance in the generation of response patterns than organismic factors associated with these severely subnormal children.

In conclusion, the present Experiment has suggested that instruction in matching to sample may be equally effectively carried out with either one- or two-choice slides. An observed simplicity in the responding of normal children performing correctly at a similar level to S.S.N. children in the Experiment has offered the possibility of speculating about the importance of Instructions in determining the exact form of response patterns in S.S.N. children, and it has been suggested that they may be of less importance than other organismic cariables associated with severe subnormality.

(4) Experiment 3

(i) Introduction

Experiments 1 and 2 have yielded information about the responses of S.S.N. children to the Touch Tutor based upon only one sample of children. Experiment 3 was designed to minimize this limitation by providing data obtained from a different sample of such children. Prior to a study of the Touch Tutor in a classroom setting (see Chapter 8) children from a residential hostel ('Redcourt') were studied while they worked on the Touch Tutor over two experimental sessions in the Mobile Laboratory. During that time they received similar treatment to that which children in the 'One-Choice' Instruction Group received in Experiment 2.

(ii) Method

23 of the 26 children (three were on holiday) who attended daily the school of the 'Redcourt' hostel were each given the

opportunity to work with the Touch Tutor for two sessions in a manner identical to that adopted for the conduct of the 'One-Choice' Instruction conditions of Experiments 2 and 2a. Children were brought individually from their school classrooms to the Mobile Laboratory and were immediately given the Introductory Instructions. Owing to the newness of these children to the Mobile Laboratory and the machine some children required re-assurance or some initial prompting in order to respond. One child, for example, insisted upon holding the Experimenter's arm while responding, which was permitted. Another child seemed to believe that shouting at the machine would make the pictures change and initial prompts to 'Touch the pictures' were given. Apart from such departures from the exact procedure of Experiments 2 and 2a, which seemed necessary for the confidence of certain children, the procedure of Experiments 2 and 2a was followed closely. All the prompts and re-assurances which were made were recorded from the videotaped recordings of the children during the Experiment.

No M.A. or I.Q. data were available for the sample as a whole but all the children were described by the Principal of the hostel as '.S.S.N.', and it is believed by the author that the children were broadly similar in 'ability' to the children who took part in Experiments 1 and 2. The C.A.'s of the sample ranged from 6 to 16 years, median 12 years.

The Experiment was conducted during October and November, 1970.

(iii) Results

(a) The Touch Tutor's 'attractiveness'.

During the course of the Experiment it appeared that approximately one third of the children were finding no interest in the machine, in that they made no responses to the touch panels during either of the two sessions. Only one child showed any marked change in responding in these terms, beginning the Experiment by responding and ending the Experiment by not responding. The remaining children each completed a minimum of eight slides unaided during at least one part of the Experiment, as can be seen from Table 6.7. The Table shows the numbers of children completing the minimum of eight slides during blocks of one- and two-choice slides at the beginning of each of the two sessions and during blocks of two-choice slides at the end of each session. It will be remembered that each Session consisted of 56 slides, of which 46 were for children to complete alone. The consistency of the children's responding should be noted, with respect to the Table; thus, the Table refers to just 15 separate children.

Table 6.7

Numbers of children completing a minimum of 8 slides during parts of Experiment 3.

	Session 1			Session 2		
Slides:	11-20 (1c.)	21-30 (2c.)	47-56 (2c.)	11-20 (1c.)	21-30 (2c.)	47-56 (2c.)
No. of children:	14	15	11	14*	13*	13*
n.	23	23	23	22*	22*	22*

Key: * 1 child absent.

The data of Table 6.7 may be compared with the data obtained under similar conditions during Experiment 1, although it must be recognized that the conditions are not exactly comparable. Such comparisons are given in Table 6.8, which indicates the numbers of children in Experiment 1 ('Stallington') and in Experiment 3 ('Redcourt') completing a minimum of 8 slides at similar stages of the Experiments. The data for 'Stallington' are taken from the stages of that Experiment bearing the labels used in the Table; those of 'Redcourt' from the first 20 slides of Session 1 and the last 10 of Session 2.

Table 6.8

Numbers of S.S.N. children in two samples completing a minimum of 8 slides during different stages of Experiments 1 and 3.

	Experiment 1 ('Stallington')	(n.= 52) (% of n.)	Experiment 2 ('Redcourt')	(n.= 23) (% of n.)
'Pre-test'				
'One-Choice' slides:	31	(59)	14	(61)
*'Two-' or 'three-choice' slides:	28	(54)	15	(65)
'Post-test'				
'Two-choice' slides:	26	(50)	13**	(59)

Key: * 'Two-choice' for Redcourt: 'Three-choice' for Stallington.
** n. = 22.

Statistical analysis of Table 6.8 by the χ^2 test suggests that the numbers of children completing 8 slides, expressed as proportions of the total number of children in each Sample, are similar in both Samples. As an example, the largest difference in percentage frequency (11%) may be taken, for which χ^2 = 0.44 (N.S.). At the end, therefore, of the Experiment 59% of the Redcourt children were responding to the Touch Tutor at the minimum criterion level of 8 slides completed, a similar percentage of children in the total sample to that obtained from Experiment 1.

During the Experiment the children recorded in Tables 6.7 and 6.8 generally worked well, requiring few prompts although not all children (as can be seen from Table 6.7) completed full sessions on the machine. To be more precise, 11 children completed the 36, two-choice slides of Session 1, while the remaining children completed 22, 19, 16 and 10 slides respectively; all 13 children who made a minimum of 8 responses during Session 2 completed both the series of 10, one-choice slides and the series of 36, two-choice slides.

Table 6.9 provides additional information on these children by indicating the time children took to complete certain slides during the Experiment and their response rates while doing so. Two sets of data referring to the whole Experiment are given in the body of theTable. The first (labelled 'a') set of data was computed in a similar manner to the data in Tables 5.2, 5.3 and 5.4, that is, by taking the total number of slides completed during the whole Experiment by children completing 8 slides or more during one part of it, together with the total time spent in the Mobile Laboratory during the Experiment.(1) The second set of data (labelled 'b') was computed in a similar manner, but with the exclusion of the data from slides 1-20 of both Sessions, in order to facilitate comparison with data from Experiment 2 (Table 6.3). Taking the data without adjustment, children spent an average of 17 minutes 37 seconds in the Mobile Laboratory during the experiment during which they completed a mean of 80. 3 slides unaided (S.D. 18.18) at a mean rate of 4.62 slides per minute (S.D. 1.12).

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(1) Data from slides 1-20 of Session 2 was excluded for this computation, since children in Experiment 1 did not receive such a series of slides.

Table 6.9

Amount of time (in minutes and seconds) spent by 15 children working at the Touch Tutor during Experiment 3 and the mean number of slides they completed in each minute ('response rate').

Time spent on machine

	Session 1		Session 2		Both Sessions	
Slides:	11-20	21-56	11-20	21-56	1-56 21-56 ('a')	21-56 21-56('b')
Mean	2-20	6-13	1-56	5-31	14-35	11-00
S.D.	1-19	1-46	0-32	0-40	3-33	2-42
n.	15	15	13	13	15	15

Response rate

	Session 1		Session 2		Both Sessions	
Slides:	11-20	21-56	11-20	21-56	1-56 21-56('a')	21-56 21-56('b')
Mean	5.19	5.28	5.60	6.62	5.01	5.66
S.D.	2.16	2.14	1.55	0.85	1.40	1.67
n.	15	15	13	13	15	15

A marked feature of Table 6.9 is the considerable reduction in the variance of times and response rates which occurs after Session 1. This is reminiscent of the data of Experiment 2, during which reductions were also apparent as the Experiment proceeded. In both Experiments this reduction was caused not so much by the reduction of extremely long response times as much by increases and decreases in non-extreme times. The implication of this regression to the mean is difficult to see, for it suggests the existence of what may be termed a 'characteristic' response rate for the practiced 'operator' of the Touch Tutor which is independent of the particular response pattern that operator may be exhibiting, for children in both samples who showed increases and decreases included those who were responding with an incorrect pattern of response as well as those who were responding correctly.

Comparisons of the response rates of the present Experiment with those of the previous Experiments showed that the rates were much closer to those of Experiment 1 than Experiment 2. Thus the mean rate for the whole of the present Experiment (5.01), excluding slides 11-20 of Session 2, did not differ from the rate of

Experiment 1 ('t' = 1.594, N.S.), but did differ from that of the first Session of Experiment 2 ('t' = 2.195, p.<0.05, 2 tailed). For the latter test, it should be noted, it was necessary to use a mean rate for the present Experiment which excluded slides 1—20 of both sessions, as they were excluded from the computation of mean rate for Experiment 2; this mean rate (5.66) was slightly higher than the overall rate. Both of the above 't' tests were for independent means and in both cases the variances of the samples were homogeneous.

During the first 20 slides of Session 1 prompts had to be given, for a variety ofreasons. A common one, which had not arisen in previous Experiments, was a hesitancy of children to touch the machine which gave the impression that they were expecting the pictures shown on the machine to change without their intervention (no doubt like a television set!). These children were different from another group of children who did not respond; these latter children were similar to children in previous Experiments in their extreme unwillingness to make any responses. Both groups of children were given prompts to respond; the prompts were effective for the former group in encouraging their responding, and could soon be dropped, but they were ineffective for the latter group who could not be induced to make more than the odd response by a combination of prompts and demonstrations. It is certain that prompting raised the performance of some 6 children during these slides, although 8 children completed the minimum of 8 slides with no prompts whatsoever. After this, however, performance did not depend on the use of prompts; during the remaining slides of Session 1 four children received a single prompt and one child received three prompts. Performance was still better in Session 2 with one child receiving two prompts and the remainder none. Prompts were, therefore, generally uncommon after children had been working on the Touch Tutor for 10 slides.

So, to summarize, 'Redcourt' children worked on the Touch Tutor in a similar manner to 'Stallington' children during Experiment 1, in terms of the proportion of the Sample completing a minimum of 8 slides on the machine and in terms of the overall response rate of the Experiment. Some children in the 'Redcourt' sample seemed to show an initial reluctance to respond to the Touch Tutor not shown by 'Stallington' children which, it was believed, was due to a "misconception" about the nature of the machine. During the Experiment children responded to the

Touch Tutor for an average time of approximately 16 minutes, completing an average of approximately 83, out of a possible 92, slides during that time. 8 children (approximately one third of the total sample) did not respond to the Touch Tutor for the minimum of 8 slides.

(c) The extent of correct responding ('matching to sample')

Few children in the Sample were able to match to sample at the beginning of the Experiment, and few more were able to do so by the end of the Experiment. All of the children who completed a minimum of 8 one-choice slides completed them correctly. Table 6.10 shows details of the numbers of children responding correctly to different slides at different stages of the Experiment, together with the corresponding data from Experiment 1.

Table 6.10

Numbers of S.S.N. children in two Samples responding correctly to at least 8 slides during sections of Experiments 1 and 3.

	Experiment 3 ('Redcourt')					
	Session 1			Session 2		
Slides:	11-20	21-30	47-56	11-20	21-30	47-56
Type of slide:	(1c.)	(2c.)	(2c.)	(1c.)	(2c.)	(2c.)
No. of children:	11	1	1	13	3	2
n.	14	15	11	14	13	13
N.	23	23	23	22	22	22
% of n.	79	7	9	93	23	15
% of N.	48	4	4	59	14	9

	Experiment 1 ('Stallington')				
	Session 1		'Post-test'		
Slides:	11-20	21-30	1-10	11-20	21-30
Type of slide:	(1c.)	(3c.)	(1c.)	(2c.)	(3c.)
No. of children:	22	7	25	6	7
n.	31	28	33	26	25
N.	52	52	52	52	52
% of n.	71	25	76	23	28
% of N.	42	14	48	12	13

Significance levels of comparisons

p. (2 tailed):	0.44*	0.52*	0.34*	0.76*
	0.90**	0.46*	0.70**	0.74*

Key: 'n' = number of children completing 8 slides or more.
'N.' = number of children studied during a section of the Experiment.
'*' = Fisher Exact Probability Test
'**' = χ^2 Test.

The first line of statistical comparisons in Table 6.10 shows the results of comparing the numbers of children responding correctly in the two Samples as proportions of the numbers of children completing 8 slides and the second line those of them as proportions of the total Samples. It will be noted that the proportionate numbers in each Sample are not significantly different.

During Experiment 1 seven children showed improvements and four children showed deteriorations in performance between the Pre-test and Post-test Stages of the Experiment on one-choice slides, while on three-choice slides two improved and two deteriorated. In the present Experiment such 'inconsistency' was less marked, with only two children showing marked changes; thus, one began Session 1 by responding at criterion to two-choice slides and ended the Session by failing to do so, and the other child did the same thing in Session 2.

(iv) Discussion and Conclusions

The overall impression gained from watching children from 'Redcourt' working on the Touch Tutor was that there were many similarities between their responding to it and that of 'Stallington' children. Thus, some children were keen to touch the machine and some were not, only one child seemed actually frightened of it (and could be induced to make no responses) and children engaged in the kinds of response patterns noted in 'Stallington' children.

This general impression of similarity has been confirmed in the comparisons which have been made of rates and correctness of responding between the two samples of children.

We may ask, however, whether this apparent similarity in the behaviour of children is a realistic finding - for the procedures of the two Experiments were, in some respects, different.

Perhaps the two major differences in procedure were, firstly, the 'Exploratory Studies', which affected 16 of the 52 children in Experiment 1 and, secondly, the length of that Experiment, which was approximately twice that of the present one. Let us look briefly at some details of the results of Experiments 1 and 3 with regard to these differences. With regard to the first difference, it is interesting to note the larger number of children in the 'Stallington' sample who were, at the start of the Experiment, able to match to sample. Turning to the appropriate section of Chapter 5 (page 90), it appears that seven children were thought to be matching to sample in the Exploratory Studies; reference to Appendix 1 reveals that many of these children continued to match correctly at the beginning of Experiment 1. It could, therefore, have been the effects of the Exploratory Studies which gave rise to the slightly greater number of children able to match to sample at the beginning of Experiment 1 than were able to do so at the beginning of Experiment 3.

With regard to the second difference it was a noticeable occurrence in the data of Experiment 1 (see Tables 5.1 and 5.5) that, although some children 'improved' in performance as the Experiment proceeded, a rather similar number 'deteriorated'. This was not true of Experiment 3, where little 'deterioration' was noticeable. It may be that the greater length of Experiment 1 was a major contributory factor in this 'deterioration'. On the other hand, there are grounds for regarding such events as fluctuations, rather than directional trends, in children's performance; inspection of Experiment 2 (Table 6.4) reveals clear fluctuations from 'criterion' to 'non-criterion' responding as the Experiment proceeded. To the extent that this is a more parsimonious explanation of the data than one which supposes trends, it should be adopted.

It would appear, therefore, that the two differences in experimental procedure between Experiments 1 and 3 may be regarded of minor importance in comparing the effects of the Experiments upon the children's performance on the Touch Tutor. We may conclude that the two Experiments have given similar results concerning the behaviour of children on this machine.

(5) Conclusions to Chapter 6

The three Experiments reported in this Chapter have gone some way towards clarifying the results of Experiment 1. Experiment 2 suggested that the use of one-choice slides for the introductory instructions in Experiment 1 had not, in comparison to the use of two-choice slides, been a significant cause of children not matching to sample; Experiment 2a seemed to confirm this finding. In Experiment 2a it also appeared possible that too much stress was being laid upon small variations in the Instructions children received, when it was discovered that normal children, who were similar in extent of matching to sample performance to a group of S.S.N. children, were not touching all the panels of the Touch Tutor - a pattern of responding which had been tentatively blamed upon the use of one-choice slides for introductory Instruction. Experiment 3 gave rise, despite some variations in experimental procedure, to similar conclusions concerning the behaviour of S.S.N. children to those drawn from Experiment 1.

Experiments 2 and 3 have also extended the results of Experiment 1. Thus, Experiment 2 provided details of the responding of children to the Touch Tutor over a number of further sessions, suggesting the value of these in promoting matching to sample in certain children, while Experiment 3 offered more detailed quantitative data about the responding of a sample of children of whom none had experienced the Touch Tutor prior to the Experiment. No major new information came out of this, however, with the exception of the picture it painted of the initial effect of the machine upon children completely unfamiliar to it. Children initially required assurance and prompting to respond, a hesitancy mirrored by low response rates.

These Experiments have not yet provided information upon two further questions raised in Chapter 5 in connection with Experiment 1. These concerned the specific effect of the Instruction procedure of Experiment 1 and the problem of the nature of response patterns, about both of which little data was available for examination from Experiment 1. Since relevant data was obtained during the Experiments reported in this Chapter let us turn next to a consideration of it in connection with these two questions.

CHAPTER 7 : DETAILED STUDY OF CHILDREN'S RESPONDING TO THE PANELS OF THE 'TOUCH TUTOR'.

(1) Introduction

This chapter is intended to have a relatively minor role in the exposition of the general argument of the thesis. However the role it does play, although small, is important, for the intention of the Chapter is to clarify some of the problematic aspects of the First Study by further investigation of the behaviour of S.S.N. children to the Touch Tutor. This clarification is achieved by the relatively simple expedient of studying the behaviour of such children while working upon the Touch Tutor in considerably more detail than was possible in Experiment 1. The particular aims of the Chapter, which were developed from the problems which arose during Experiment 1, are to provide a detailed description of certain aspects of the responding of children to the stimulus and response panels of the Touch Tutor with a view to evaluating further the effects of the instruction procedure which was used to introduce children to the experimental task in Experiment 1, and to provide some degree of explanation for the appearahce and maintenance of a number of incorrect patterns of response adopted by children in Experiment 1. Our next task will be to discuss how to obtain a comprehensive description of the behaviour of children to the Touch Tutor in such a way that further light may be shed on the problem of further evaluating the effects of the instructions used, and upon the characteristics of the response patterns. One way of doing this is to examine the assumptions made in Experiment 1 about the instruction procedure used, the assumptions which might be made about incorrect patterns of response from previous discussions of them, and to examine how far a detailed analysis of children's responding to the Touch Tutor might show the extent to which such assumptions are justified.

The intended effects of the Instruction procedure used in Experiment 1 were that it would aid children to match to sample. Specifically, it was hoped that children would copy the act of touching the top panel of the machine, in addition to one of the bottom ones, and that when they did this it would improve the correctness of their responding. It would, therefore, be important to determine how frequently the behaviour of touching the top panel occurred in the performances of children being given these instructions and whether responses to the top panel, when made, typically led to correct matching to sample. If children typically did not touch the top panel of the machine and, more specifically, if they did not touch it before touching the bottom panels of the machine; or, if they touched the top panel but did not typically follow such a touch with a correct response, the efficacy of the procedure in achieving its aims might be doubted.

The possibility arose in Experiment 1 that the use of one-choice slides in the Instruction procedure was having a deleterious effect on children's matching performance. The possibility was heightened by the development, in some children, of a tendency to touch all the response panels in turn on the appearance of a slide, suggesting that one of the effects of using one-choice slides had been to tell them to 'touch all the pictures and make the machine work' rather than to 'touch the pictures which are the same and make the machine work'. One way of evaluating the deleterious effects of using one-choice slides for instruction would be to consider the differences in responding created by giving children instruction with two-choice, rather than with one-choice slides. We might expect on the basis of the above discussion that the touching of each response panel in turn would occur less frequently under conditions of instruction with two-choice slides.

The term 'response pattern' refers to a systematic mode of responding adopted by a child towards a task such as, in the present studies, that presented by the Touch Tutor. Although correct matching to sample can be thought of as a response pattern the term has come to be used to describe incorrect ways of responding in a task. Other terms have been used to describe similar phenomena; Krechevsky (e.g. 1932a), for example, talked of 'hypotheses' in rats learning a discrimination task, and the phrase 'response habits' has been used interchangeably with these terms.

Two broad types of response pattern attracted our attention in Experiment 1. Firstly, it had been difficult to see why children repeatedly touched the response panels of the machine until the slide changed, even when they had responded correctly and had heard the machine speak. Secondly, children had developed habits associated with their first response to the lower, response panels of the machine after the appearance of a slide; an example of this kind had been the tendency in some children to touch always the same position of the response panel area on the appearance of a slide.

Discussion of the former pattern of response has been sparse, although similar patterns have been noted by those who have worked with similar machines and children. Hively (1960, 1962), Sidman and Stoddard (1967) and Bijou (1968) each note the appearance of this kind of response pattern (although without reference to it in relation to the machine <u>speaking</u>: their machines, it will be remembered, offered no such reinforcement for correct responses), with Hively and Bijou attributing it to unintended contingencies of reinforcement and Sidman and Stoddard to the child adopting an optimum mode of response for the acquisition of reinforcement after an incorrect response. The interpretations of such response phenomena do not seem to be the result of careful analysis of the data; rather they seem to be broadly reasonable intepretations in the light of the authors' 'operant' approach.

One slightly contrasting explanation which could be offered for them is that they represent a facet of exploratory behaviour which can be a feature of the behaviour of the normal child of approximately 3 years of age. His exploratory behaviour may tend to be both manual and impulsive (<u>e.g</u>. Zaporozhets, 1961) and is, therefore, behaviour the child brings to the task rather than behaviour developed by it. It would seem a vital first step to explanation that we should study the characteristics of this response pattern's occurrence; once in possession of descriptive data, possible explanations may be examined. In such descriptive study it would be important to determine how typical of the behaviour of different childrn was this pattern of response, and something of the extent to which it was related to the different reinforcements ('speaking', and 'slide-moving') provided by the machine. Knowledge of these two aspects of this response pattern would reveal just how widespread such behaviour was in the children studied, and enable some discussion of the power of 'operant' or "contrasting" explanations to be assessed.

Discussion of the second kind of response pattern has been comparatively extensive. Incorrect patterns of response associated with the first response to response panels after the appearance of a slide have been reported in most of the studies described in Chapters 2 and 3 of this volume and apparently similar ones have been noted in a variety of studies in which animals and children (both normal and subnormal) have responded overtly in order to gain some kind of reinforcement. For example, Fellows (1965) reports the appearance of such response habits in normal children aged five years and below in a matching to sample task, Schusterman (1963, 1964) and Baumeister (1966) in subnormal children, and severely subnormal children, working on two-choice discrimination learning tasks of standard format; Gerjuoy and Winters (1968) and Goulet and Goodwin (1970) in subnormal and normal children working on tasks of the 'probability learning' type in which no pattern of response will lead to reinforcement every time; and Goulet and Barclay (1967) and Goulet (1969) in the behaviour of normal and subnormal children working on problems in which reinforcement is completely unrelated to choice behaviour, when only guessing is possible. Similar phenomena have been observed and studied with animals in variants of two-choice discrimination learning tasks (e.g. Krechevsky, 1932c; Sutherland and Mackintosh, 1971, with rats; Harlow, 1959, with monkeys), and with college students (e.g. Levine,1966).

Despite the differences in tasks, subjects and the purposes of these studies there are many similarities in the response patterns and their characteristics they report. On the basis of these various studies, three broad generalizations about such response patterns can be made. Firstly, that they are widespread features of the pre-solution behaviour of rats, monkeys, subnormal and normal children(1), instances of random responding are rare. Secondly, a broad correspondence between mental age and the type of response pattern emerging in a task exists; very young children of normal ability and subnormal children with equivalent mental ages show tendencies to respond in two-choice discrimination learning tasks in a manner which may be described as position perseveration. That is, on the appearance of the stimulus materials for each new trial they will tend to respond to the same position of the response area. Rats, also, seem to favour this pattern (Krechevsky, 1933a). Slightly older children may still show a tendency to respond to the positioning of the stimuli, but to respond to alternate positions. Older children, with mental ages of five and above tend to show response patterns based increasingly upon the outcome of a choice, and may respond to the same or to alternative positions on subsequent slides, depending upon whether responses to a position on the previous slide were rewarded. These children, too, are better able than the younger children to learn visual

(1) The majority of such studies are with mildly subnormal children, although some have been conducted with S.S.N. children.

discriminations. Thirdly, the response pattern behaviour of the younger child below a mental age of five years tends little to be affected by changes in the task such as the kinds of instructions used, and the particular reinforcement schedule used for rewarding correct responses, while that of the older child, above this age, tends increasingly to vary as a result of such changes in the experimental task. Let us now look at these three features of response patterning in slightly greater detail, and attempt to understand some of the mechanisms which underlie these features.

It is hard to tell whether the few instances of random responding which seem to occur in accounts of response patterns are due to brief reporting, or to their real infrequency. However, there is evidence that in the case of animals with intact brains it is the latter explanation which is the accurate one. Lashley (1929) attributed the very fact of response patterning as opposed to random responding to the characteristic mode of operation of the intact brain: "One does not realise the meaning of 'random' behaviour until he has compared a normal animal with one having extensive cerebral destruction..." (op. cit., p.138). In his studies of maze- and discrimination-learning in normal and in brain-damaged rats, it seemed that response patterning was a normal and characteristic feature of the behaviour of animals exploring new situations.

A similar conclusion about the widespread nature of response patterning comes from the many studies of humans in which subjects have been asked to produce or recognize random sequences of material (e.g. Tune, 1964; Cook, 1967). Typically, subjects find this a difficult task, suggesting than randomness is alien to the brain's operation.

Unfortunately, what do not seem to be available are data concerning the responses of represenatative samples of severely subnormal children; it is, therefore, difficult to know to what extent random responding is characteristic of the behaviour of these children in problem solving tasks.

The broad correspondence of mental age to the type of response pattern which emerges in a task, and to the extent to which they are affected by task variables, has received support from a number of workers, although few of them have attempted to determine with any exactness why this should be so. Reviews of the literature upon response patterns by Gerjuoy and Winters (1968) who concentrate upon studies with subnormal children, and by Goulet and Winters (1970) who have reviewed the literature in relation principally to young normal children agree to the presence of a strong developmental component in response patterning and agree that this seems to change from strong position perseveration in the young child with a mental age of approximately three years, to strong position alternation at a mental age of about 5 years, to more complex hypotheses based on outcome at the age of about 7 years and above. Similarly, children below 5 tend to be relatively unaffected by specific task variables in comparison to older children. It should be noted, as is the case in attempting to attach ages to behavioural phenomena of developmental significance, that these ages are not intended to be thought of as definitive, but rather as general guidelines to the approximate relation of age to the characteristics of children's response patterns. There is slight disagreement, for example, between different studies as to the precise age range appropriate to the appearance of different response patterns, and in some cases the results of samples of normal children are used as the basis for generalizations about subnormal children. Nevertheless, there is broad agreement that marked shifts in the type of response pattern tend to occur at the ages of 3, 5 and 7 years in the normal child, and that this seems to hold, broadly, for subnormal and severely subnormal children of equivalent mental ages.

These shifts correspond to other changes in the cognitive functioning of the normal child which seem to take place at these ages. White (1965) has amassed evidence from a number of studies of cognitive processes in child development that the age range 3 to 7 years and immediately above is a time of marked qualitative change in mental organization. Particularly during the ages of 5 to 7 years the normal child seems to go through a period of transition in which "a widely ramified system of juvenile mental processes gives way to higher mental processes" (op. cit. p.213). Before this transition, White supposes, the child learns problems by a set of processes which might broadly be described as 'associative'. By this White implies that the child indulges in behaviour which is regulated not predominantly by voluntary acts, but rather by aspects of the immediate task. The older child, in contrast, shows less dependence on the immediate aspects of the task by exhibiting a degree of controlled choice over his actions. White terms this, simply, the 'cognitive' set of processes.

Three examples follow which make White's thesis clearer. Razran (1933) reviewed studies of the ease with which young children could be 'classically conditioned'. He noted that the susceptibility of children increased until the age of 6 years, after which it showed a marked decrease. Similarly, Stevenson and Weir (1961) concluded, after reviewing data obtained from normal children in a knob-pushing task in which marbles could be obtained as reinforcement, that the single S-R unit of analysis was inappropriate for describing the behaviour of children of seven years of age and above. Children of this age tended to adopt alternative responses after reinforcement as often as after non-reinforcement; younger children tended to repeat rewarded responses and discontinue non-rewarded responses. Thirdly, Zaporozhets (1957, 1961) reports that a three-year-old child when faced with the problem of getting a toy car through a 'maze' of 'streets' will tend to grasp the car and push it through the maze without regard to blind alleys and wrong turnings. With practice he will learn to take the car through more 'correctly', and his performance is likely to agree with that predicted by such classical S-R theorists as Hull. The seven-year-old child, on the other hand, is likely to engage in visual exploration of the maze, avoiding false turnings before coming to them, and showing a degree of 'planning' in his approach to the problem, which gives his learning more of the appearance of 'insight'.

A popular interpretation of the nature of this transition draws upon the concept of a 'mediating response'. If a child seems to do something 'after thinking about it' which, as we have seen, seems to differentiate the older from the younger child, it would seem important to ask about the nature of this 'thought'. Since the behaviour of the 'thinking' child is more efficient than that of the impulsive, non-thinking child, it would be reasonable to suppose that during this period of thought the child is engaging in some internal analysis of the problem. A number of workers (e.g. Vygotsky, 1962) have suggested that it is the internalization of language which permits such internal analysis, the word becoming the effective basis of action rather than the external stimulus, and hence a 'mediating response'.

Our discussion so far seems to suggest that the transition in the type of response pattern with age, and in the effect of task variables on response patterns with age has a marked similarity to transitions in other aspects of children's behaviour which take place at similar ages. This in turn suggests that this transition is brought about by an increasing facility in conscious, planned behaviour which begins to take precedence over 'associative' behaviour, to use White's term, in learning tasks. One important aspect of this transition appears to be the emergence of language in the child as a means of regulating his problem-solving behaviour. However, this discussion has touched only briefly on the characteristics of the bahviour of the child who has not reached this transition stage. Since it is these children who have difficulty in the learning of discrimination tasks, and in whom rigid response patterns predominate, we shall now turn to discussing characteristics of their response pattern behaviour.

Schopler (1964) has presented evidence that exploration of a new toy is characteristically different for children of different ages. When children were offered a choice of play situations between articles which presented predominantly visual stimulation and articles which presented predominantly tactual stimulation, there was a progressive increase in the proportion of total time spent playing with the visual items from age 3 years to 9 years. Schopler also found that a sample of retarded children showed a similar progression in terms of their mental age. (In this respect it is interesting that Hermelin and O'Connor, 1961, discovered that imbeciles were superior to normal children of equivalent mental age in recognition of letter cut-outs presented tactually, and inferior in visual recognition of them.) Zaporozhets' experiments (see above) suggest, too, that children of about three years of age characteristically explore a task manually, rather than visually.

The fact that young children tend to prefer to explore new tasks manually rather than visually suggests that information presented tactually is easier to code than information presented visually. If this were so it would go to explain why children of this age are inferior in the acquisition of visual discrimination habits in tasks such as the two-choice discrimination learning task, which require attention to be paid to the visual characteristics of the stimuli presented rather than information which could be obtained from tactile input. Since older children seem to prefer visual exploration, one might expect that they would be inferior at learning discrimination tasks with 'tactile' solutions and, indeed, there is some evidence that this is the case. Schusterman (1964) presented a task which required the learning of a positional discrimination to children of low and high M.A. and discovered that the rate of learning this discrimination related inversely to M.A.[1]

What this implies, is that in addition to effects of reinforcement on the behaviour of the young child, one should consider the effect of the direction of the child's attention at the time. If it is in the 'wrong' direction the effect would be to change the functional effect of the reinforcement contingencies.

Several authors have attempted to provide comprehensive accounts of the likely interaction of attentional factors and reinforcement in two-choice discrimination learning tasks. Of these perhaps the most relevant and comprehensive for our present purposes are those of Sutherland and Mackintosh (1971) and Zeaman and House (1963). While the former was devised to account for aspects of rat learning on the Lashley jumping stand on two-choice tasks, and the latter to account for aspects of the learning of severely and moderately subnormal children on two-choice discrimination learning tasks, presented on the Wisconsin General Test Apparatus, they are in their fundamental respects very similar (see Sutherland and Mackintosh, op. cit. pp.470, 471).

Both of these theories assume that in learning a discrimination in the two-choice discrimination learning task the subject has to learn, firstly, to attend to the relevant (i.e. the 'rewarded') stimulus dimension and, secondly, to make responses to the correct cue of that dimension. Such a two-stage model is invoked in both theories to deal with (among others) the phenomenon characteristic of, as we have seen, many subjects' performance in such tasks that during the early stages of the task they respond to some irrelevant aspect of the task with respect to its solution, that is, they exhibit a response pattern. If the performance of such experimental subjects is portrayed in the form of a learning curve, the resulting curve exhibits an initial flat portion during which no apparent improvement is occurring, followed by a sharply rising portion to criterion. Zeaman and House point out that this is most noticeable in the performance of retarded children, in whom the length of the initial flat portion differentiates slow- and fast-learners of discrimination problems. They describe their initial findings with respect to this:

"The difference between fast and slow learning is not so much

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(1) The 'low M.A.' subjects in this experiment had a mean M.A. of 5.2 years and a mean C.A. of 10.1 years; 'high M.A.' subjects were normal children with a mean C.A. of 10.8 years.

the rate at which improvement takes place, once it starts, but rather the number oftrials for learning to start ... We surmise that the length of the initial flat chance-level stage of the performance curves is controlled primarily by an attention process, while the final, sharply rising portion of the curves is largely indicative of instrumental discrimination learning." (Zeaman and House, 1963, p.162, authors' emphasis)

Zeaman and House suggest that the learner approaches the task with a certain probability of paying attention to the relevant stimulus dimension of the discrimination task. This probability may depend on previous training, or it may depend on developmental factors, or factors related to the child's handicap. As the child responds in the task, and receives reward for choosing the experimental stimuli, the probability of the child's repeating an 'attentional response', that is paying attention to a stimulus dimension on a trial, is increased or, if a choice is not rewarded, decreased. In time, as a result of this process, the relevant stimulus dimension will operate on each trial; once this happens the speed of approaching criterion performance will be as fast as that of a child who had paid exclusive attention to the relevant stimulus dimension from the outset.

Support for this theory is given both by experimental work with severely subnormal children directed at testing specific predictions derived from the theory, and by the results of simulations of children's responding. Common to both these kinds of study is the manipulation of factors which are likely to affect the operation of attentional factors during learning. These experiments seem to bear out the principal thesis of Zeaman and House that attentional factors are of importance in discrimination learning and that manipulation of them affects the rate of learning of a two-choice discrimination task by affecting the length of the initial flat period of the learning curve.

Zeaman and House do not discuss specifically why some children fail to learn in relation to their theory. This is unfortunate, not only because it would be relevant to our present endeavour of trying to understand response patterns but because there seem to be as many children failing to learn two-choice discriminations in their experiments as succeeding, both of low (2 - 4 years) M.A. and of high (4 - 6 years) (op. cit. p.163).

The likely explanation would presumably be that non-learning children are not paying attention at all to the relevant dimensions of the task, which accordingly are not being increased in dominance by reinforcement. On the other hand, certain irrelevant stimulus dimensions are receiving reinforcement, and are therefore accordingly being strengthened (or maintained in strength) by reinforcement on a schedule of partial reinforcement. Neither attentional nor instrumental responses extinguish with time since the number of rewarded and non-rewarded responses are equal; children accordingly continue to respond in a way that reflects the aspects of the task to which they are paying attention.

Of course, if these ideas hold true one would expect that the persistent non learner could come to improve with practice if his attention were brought to notice the relevant aspects of the task, or if the reinforcement conditions were altered so that responses to 'irrelevant' dimensions of the task would be extinguished. Zeaman and House (op. cit.p.164) report experiments in which procedures designed to improve the attention-getting qualities of the relevant stimulus dimension succeeded in making the task easier to learn. Thus, using 'junk' stimuli, which are multi-dimensional stimuli such as: "an aluminium pot cover versus a green plastic scrap dish and a toy hat versus a tobacco can", enabled the majority of subjects to reach criterion (op.cit. p.164). One of the hardest discriminations appeared to be when discriminanda differed only in colour (e.g. a red three-dimensional square versus a green three-dimensional square) and in rank order between these, in increasing order of difficulty, appeared to be three-dimensional objects differing both in colour and form, form only, and two-dimensional patterns differing in colour and form (e.g. red triangle versus yellow cross) (ibid.).

With regard to changing the reinforcement schedules Lobb (1966), in a typical Zeaman and House task, gave additional non-reinforcement to responses made on the basis of irrelevant response patterns, and succeeded in reducing their occurrence. Unfortunately, discrimination learning was no faster as a result of this process. The possible reason for this was that the existing attentional responses were being weakened without new, relevant ones being given to the subject. It is interesting in this respect that Sperling (1967), using rats, found that a training procedure designed to eliminate position habits, while succeeding in doing so, failed to reduce the errors made in the acquisition of the discrimination habit by them. Thus these latter procedures would only be effective in conjunction with some specific training procedure. This could be either of the type used by Zeaman and House (see above), viz., training on the criterion task alone, or training on easier problems in a 'transfer' paradigm, or it could be any of a number of methods suggested by different workers. Thus, pre-training in the observation of important stimuli may help, as may the gradual transfer of stimulus control typical of 'fading' procedures.

It is clearly possible, in principle, to interpret some aspects of response pattern data by models of discrimination learning which take both attentional and reinforcement factors into account. Such models assume that children enter the experimental task with certain likelihoods of noticing the various aspects of the experimental situation which will be correlated to a greater or lesser extent with reinforcement once the task is under way. Under certain specifiable, in principle, rules reinforcement operates on the attentional mechanism so that in time the experimentally 'correct' stimulus dimension becomes most noticed by the child, when he rapidly approaches criterion performance; in some cases, however, it is possible that children do not pay attention at all to the relevant dimension of the task, in which cases reinforcement may operate upon attentional mechanisms perceiving other stimulus dimensions, preventing their extinction.

This is satisfactory, however, only as a general account for it does not really explain the behaviour of the persistent non-learner. The difficulty lies in accepting that a child is not attending at all to a particular, relevant stimulus dimension; if he is, why do the reinforcing aspects of the task not increase, eventually, attentional responses to it and give rise to instrumental learning? An example of this problem occurred in an early experiment of Zeaman et.al. (1958):

> "On one occasion in the course of running a discrimination experiment E. forgot to pick out the stimuli to be used before bringing the subject into the experimental room. This subject, who had failed a simple color-form discrimination for over 1,000 trials, spontaneously went to a bench containing some 20 different stimuli and selected the two which had been used for the 1,000 trials." (p.456).

House and Zeaman, who do not appear to have considered the pheomenon of response patterns per se, provide no explanation of this problem. Similarly, Sutherland and Mackintosh (op. cit.) find the problem difficult, despite the completeness of their theory. Noting (op. cit., p.486) that models derived from their theory failed to account satisfactorily for certain aspect of position habits, the writers are forced eventually into an anthropomorphically-based account of what the rat is doing, just as Lashley (1929) and Krechevsky (1938) had to do. Thus the rat is seen as "knowing" and "storing information" in a situation in which discrimination learning is both an active and a passive process (op. cit., p.485).

Presented with this impasse, it is difficult to see what more can be added to an explanation of response patterns by such further work as might be achieved in the present thesis. What is necessary, however, is not so much a deeper dig into the pit of 'explanation' for the purposes of the present discussion, but rather an examination of the responses of S.S.N. children working on the Touch Tutor in the light of the discussion so far presented. The reason for this if two-fold; firstly, comparatively little seems to have been written about the response patterns of the S.S.N. child working upon discrimination learning problems (either of the simultaneous two-choice or of the matching to sample kind) and, secondly, even less has been written about these as they occur upon teaching machines like the Touch Tutor, although their existence has frequently been noted. It will, therefore, be important to provide a description of children's reponse patterns as they occur on the Touch Tutor and to reflect upon the value of possible explanations of them which could be advanced.

We may now present the aims of the experimental work of the present Chapter in detailed form:

(1) To evaluate the effects on children's responding to the panels of the Touch Tutor of the introductory instructions used in Experiments 1, 2 and 3.

(2) To describe the behaviour of children with respect to the repeated touching of the response panels and to relate this pattern of incorrect responding to aspects of the machine's mode of operation ('speaking' and 'slide-moving').

(3) To describe patterns of incorrect responding by children which are associated with their first response upon the appearance of a new slide.

(2) Method

The reader will recall that Experiments 2 and 3 were intended to furnish data for the present Chapter as well as for the previous Chapter. Accordingly the observations which form the basis of the Results for the present Chapter were collected, while children were working through these Experiments, by means of videotaped recordings of the children's responses to the panels of the Touch Tutor. This was easy to do and the resulting tapes provided a clear and complete record of every response made by children to the machine.[2]

The tabulation of the data was made initially in the form of a transcription on to squared paper of every response made, including the Experimenter's prompts, but largely excluding the children's vocalisations (these were typically few in number). It was possible to maintain the temporal characteristics of the responding to each slide to an accuracy of approximately ± ½ second, but this accuracy dropped when considering the delay between the appearance of a slide and the first response made to it. The Experimenter prompted the subject to respond if the latter had not responded for thirty seconds after a slide appeared, so that the maximum such an interval could have been would have been thirty seconds. Where such a latency was longer than about five seconds an attempt was made to measure the interval with a stop watch; this, however, was an infrequent occurrence. In general, time was not measured as accurately as was the number and order of the responses made to each slide, where accuracy was checked by replaying the tape a number of times over sections where responding was rapid and complex. Each child's behaviour was analysed twice, to check the accuracy of the transcription, and more frequently if it was difficult to record. One aspect of timing which did receive attention was the contiguity of responses to the two events in each slide - the machine speaking and the changing of the slide - for which accuracy was, as noted above, in the order of ± ½ second.

To orient the reader four fragments of the analysis are given in Figure 7.1. One is an example of a simple-to-record behaviour and the others are ones of increasing complexity. It will be noticed that the time which elapses from the child's touch to a lower panel to the machine speaking the name of the stimulus object (should a correct response have been made), and from this until the slide-change, is a fairly fixed and constant interval. However, as the use of the word 'fairly' implies, the intervals between these events could and did vary by amounts varying from ± ½ second to ± ¾ second [1]. Allowing for this variability, the

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(1) This variability was due to three main factors. Firstly, there was variability in the length of time allowed to elapse on the tape before the stimulus name was spoken. Secondly, there was variability in the length of stimulus names. Thirdly, there was variability in the machine itself due to tape stretch and other miscellaneous mechanical happenings.

(2) An event recorder was also attached to the Touch Tutor during Experiments 2, 2a & 3 (in order to provide some record in the event of videotape malfunction) which recorded the position of each first response to the lower panels after the appearance of a slide.

typical timing of these events was thus: "Touch to a lower panel - one second of hum - spoken stimulus name for two seconds - two seconds of hum - 'beep' from machine of half a second - slide change, lasting one second". Of course, when a child made an incorrect response the machine was completely silent until the slide change occurred. Typically, therefore, hum was immediately contingent upon correct responses, the stimulus name appeared after about one second and lasted for about two, silence occupied a further two seconds, overlaid by a slight hum, a 'beep' of half a second told the machine to stop the tape recorder and the slide changed, taking about one second to do so.

Figure 7.1

Four examples of transcribed recordings of children's responses to the Touch Tutor

	Top panel responses	Bottom panel responses
Time base (Seconds):	0 1 2 3 4 5 ...	0 1 2 3 4 5 5½ 6½ Next Slide
Example No.:		
1.	T...	L...
2.	T..	R L T ....
3.		R....... L T.......
4.		R L R L C R.............L........R..

Key: Abbreviations 'T','R','L','C' refer to Top,Left,Right and Centre Panels of Touch Tutor.
Dots indicate the duration of a response.

Figure 7.1 shows fragments of the records of four children in their first Session of Experiment 2. Example 1 is easy to record, consisting of one response to the Top ('T') panel and one to the lower Left panel ('L'), in that order, each of which lasted for about one second. Example 2 shows touching of Left, Top and Right('R') panels, with the child's finger resting on the Top panel until the slide changed. Example 3 shows an example of a response continued until the point at which the machine would have stopped speaking (approximately) and responses repeated after this. Example 4 shows a most difficult record. Repeated, discrete responses are made to the Right, Left and Centre panels, with the child keeping his finger on the Right panel until after the slide-change and thus triggering the machine on the following slide, and then changing, fairly quickly, to another panel. In this last example, what the first response to the second slide should be, is a matter for debate; certainly the first response as far as the machine is concerned is the one continued from the previous slide but it may be thought that the child actually 'meant' to make his second response his first. The former interpretation was adopted by the author in his analysis of such records.

Each analysis was made after the pattern of the four examples in Figure 7.1 and contained, therefore, a time-base and a record of every response made to the touch panels of the machine. Infrequently, a child would use both hands to make clearcut responses simultaneously, or would make gross responses to the centre of the panel area with his whole hand. These were counted as incorrect responses. What constituted a response was hard to define. If a response was noticeable, however, brief, it was counted as a response. Responses in which a child kept his hand upon a panel continuously were generally counted as one response, but for the purposes of one type of analysis (those of 'Subsequent' responses - see below) additional quantification of such responses was required, by taking their duration into account.

So far, we have been discussing the mechanical transcription of the videotaped recordings and some of the conventions which were adopted for this. It is now necessary to turn to the problem of summarizing the raw data into a digestible form.

The reader will see from the fragments of records presented in Figure 7.1 that there is the possibility of studying three broad classes of response to the Touch Tutor. Firstly, there is the most significant response as far as the machine is concerned viz., the first response made to the lower panels after the appearance of a slide. Secondly, are the possibly important responses as far as helping the child to match to sample is concerned viz., responses to the Top panel of the machine. Thirdly, there are responses whose significance might be related to the reinforcing value of the slide change (see Chapter 5) viz., the child's responses subsequent to his first Top and Bottom panel responses. Let us now turn to a detailed examination of these three classes of response of which the first, as noted earlier in the present Chapter, has received considerable attention. Analysis of the research which has been performed on the phenomena of those response patterns which occur on the first response of a child to the response panels of the apparatus (Krechevsky, 1932a,b,c,d, 1933a,b, 1935, 1938) Harlow, 1959; Levine, 1956, 1966; Fellows, 1965; Sutherland and Mackintosh, 1971) revealed that these were typically interpreted by reference to series of problems in which the attributes of the correct stimulus were so arranged that any systematic pattern of responding would be unlikely to yield an above-chance score, other than correct responding.

Prior to analysis by Gellermann (1933a,b) such series were determined randomly in an attempt to remove the possibility of some systematic behaviour to an irrelevant attribute of the stimulus materials producing a better or a worse than chance score and to prevent the appearance of such behaviour by accidental reinforcement. Gellermann argued that such methods often allowed various incorrect response habits to produce an accuracy of performance as high as 70% due to the faulty selection of orders for the stimuli. Accordingly, he laid down (1933a) five criteria necessary to ensure a random sequence and selected 44, 10-trial series which satisfied the criteria. Thereafter, his sequences were used widely in the selection of stimuli for two-choice simultaneous discrimination learning task.

Since Gellermann's paper interest in the presolution behaviour of subjects in discrimination tasks has grown and considerably more sophisticated methods for analysing the various patterns of responding they develop have been devised. Fellows (1965, 1967), working largely from Levine's (1963) expansion of Harlow's error factor analysis (Harlow, 1950, 1959) and from further work by Bowman (1963) and Levinson and Reese (1963) applied a combination of these methods to the Gellermann series and found that (a) they failed to ensure that no position hypothesis would produce other than chance performance on the learning curve and that (b) they failed to prevent the differential reinforcement of position hypotheses. He accordingly developed an amended series (1967) and it is this series which was used here.

The series specifies the positioning of the correct stimulus on each trial for two-choice slides only where, in the matching to sample case, the configuration is always triangular thus:

A

A - C

and the centre lower panel always blank. It provides controls against the two problems noted above for several types of response habits. The best way to describe these is in the form of a table; it is adapted from Fellows (1968) (Figure 7.2).

Figure 7.2

Response patterns involving first responses to the lower panels only, after the appearance of a slide (adapted from Fellows, 1968)

Response on Preceding Slide	Outcome	Response on Slide under analysis	Description	Label
		Rm	Matching	M
		Ro	Oddity	O
			Responding	
P1	+	P1	Win-Stay	W
P1	-	P2	Lose-Shift	
P1	+	P2	Win-Shift	L
P1	-	P1	Lose-Stay	
P1		P1	Position	
			Perseveration	PP
P1		P2	Position	
			Alternation	PA

For explanation see text.

The first column of the Figure shows the response made on the slide preceding the response under analysis. (The analysis is restricted to the first response to the lower panels after the appearance of the slide). The abbreviation 'P1' is the position responded to on the previous slide; 'P2' the position not responded to.

The second column shows the coutcomes of the response on the preceding slide and the third column the response under analysis. Rm denotes the response was a correct match; Ro a response to the non-matching or Odd stimulus. Conventional descriptions and abbreviations are given in the third and fourth columns.

Using the method, a series of 36, two-choice matching to sample slides (see Appendix 2) was prepared from the slides used in Experiment 1. Additionally, controls were made against the possible accidental reinforcement of, and bias in the results from, habits of stimulus perseveration. The control consisted of arranging the stimulus pictures so that each picture appeared equally often in either left or right positions and as the correct or incorrect stimulus; the order of their appearance was determined randomly. The sequences were than checked to ensure that no systematic response to one picture alone would produce above or below chance responding.

The transcribed raw data were analyzed in line with the conventions of Figure 7.2 and with the conventions described earlier so that each response which had caused the Touch Tutor to operate(1) was categorized as an instance of one of the response patterns described in Table 7.1. It will be appreciated that one response may be described under a number of patterns. The beauty of the Fellows' series was such, however, that a run of responses could be caused by only one of the 'hypotheses' (or extremes of chance).

Description of the data concerning Top and Subsequent responses could not be made on the basis of previous research but had to be made on the basis of apparent differences in the patterning of these responses, in conjunction with hypotheses about possible patterns derived from the observations of children made during Experiment 1. Thus, in the case of Top responses, three kinds of such response were noticeable, of which the first was of particular interest in the light of the intended effects of the Instructions on the children. The first kind of Top response occurred as the first response a child made to the Top panel of the machine after a slide had appeared. Some children, however, responded to a lower panel after a slide had appeared, making a Top response their second response to the slide. This was the second kind of Top response. Thirdly, and less frequently than these, Top responses were made after a response to each of the two lower panels, so that the Top response was the third response of the slide. On occasions, Top responses were made after a number of responses to the lower panels had been made. They were then classified as responses of the third type of Top response. Occasions also occurred when

(1) Or rather, which should have caused it to operate. One of the problems of the Touch Tutor was that it did not always respond to the touch a child had made, sometimes because the child's fingers was dry and no electrical contact was made. The author, therefore, as a matter of course, used hand-held buttons to trigger the machine as the child made his first response to the lower panels. The effect of this was in no way different from the intended mode of operation of the machine. The procedure was used in all Experiments described in this and in the preceding Chapter.

a Top response and a response to a lower panel were made simultaneously by the child using two hands. These were classified as Top responses of the first kind. Illustrations of these three types of Top response are given in Figure 7.3, together with the abbreviations given to them by the author.

Figure 7.3

Examples of three types of Top response

		Top panel responses	Bottom panel responses
Time base (seconds):		0 1 2 3 4 5..	0 1 2 3 4 5 $5\frac{1}{2}$ $6\frac{1}{2}$ Next Slide
Example No.:	Abbrev.		
1	"TB"	T..	L....
2.	"BT"		L.. T..
3.	"B..T"		L..R..T..
4.	"B..T"		L.....R.....L..T..
5.	"TB"	T..	R..T..L..

Key: The abbreviations 'T', 'R', etc. refer to the different panels of the Touch Tutor, as in Figure 7.1, and the dots indicate the duration of a response.

Figure 7.3 shows examples of Top response of different kinds. The first three examples are straightforward. Example 4 shows a case of repeated responding to the lower panels with a Top response occurring at the end of the slide. Example 5 shows an occasional phenomenon; the child made more than one response to the Top panel of the Touch Tutor. In this case, and in all others like it, the first Top response would be recorded and classified and the remainder would be 'ignored'. All occurrences of Top responding were classified under one of these three headings.

There were many occasions upon which children made responses to the Touch Tutor after making a Top and a Bottom response or, if no Top response were made, after making one Bottom response. These were designated 'Subsequent' responses. Some difficulty in interpretation was posed by unbroken touching of a panel for several seconds; the convention followed was to regard such touching as one response unless it lasted for two seconds or more, when it was regarded as an example of a Subsequent response. This time limit was based on the fact that discrete reponses tended to last for approximately one second, in which case a two second response would be comparatively long.

Subsequent responses posed extreme difficulties of sub-classification. Examination of the data and attempts at classification eventually suggested the value of four categories of Subsequent response with one further category for difficult-to-classify responses. The first of these four types of Subsequent response was designated the 'Simple' ('S') type and comprised instances of such responding which occupied no more than the first $3\frac{1}{2}$ seconds of a slide, after the first Bottom response of a slide. This period corresponded to the machine speaking, if a correct response had been made. The second type was designate the 'End' ('E') type and comprised instances of subsequent responding occupying the whole of the slide and ending as the slide disappeared. The third type was designated the 'Past End' ('PE') type and included instances of responding continuing into the next slide. The fourth type, designaged the 'Confirmatory' ('C') type (because they had the character of being confmrations that the machine was actually working!) were cases in which one or two isolated responses were made near the end of a slide, after the middle period of the slide had contained no responding. Subsequent responses which could not accurately be classified were labelled 'Other' ('O'). All instances of Subsequent responding were classified in one of these five ways. Occasionally, children made more than one response to the Top panel of the Touch Tutor before responding to one of the lower panels; these were infrequent occurrences and were disregarded.

Figure 7.4 shows examples of these different types of Subsequent responses.

Figure 7.4

Examples of five types of Subsequent responding

Example No.:	Type	Time base (seconds): 0 1 2 3 4 5 $5\frac{1}{2}$ $6\frac{1}{2}$ Next slide
1.	"S"	L..T .. R...
2.	"S"	L.....R.......
3.	"S"	R..R..L..T..T..
4.	"E"	R........L..............
5.	"E"	L...T...R..T..R..L......
6.	"PE"	R...L....T...... T..L..... L............
7.	"C"	R..T.. R..
8.	"O"	R........L........
9.	"O"	R..L..R........ L..

Examples 4 and 5 show typical instances of responses of type 'E', as do examples 6 and 7, of types 'PE' and 'C'. Example 8 shows a case in which it is difficult to say whether the response should be designated as 'E' or not. Example 9 shows a case in which it is difficult to say whether the response should be designated as 'E' or 'C'. In general, 'C' responses were cases in which responding continued into the period between the $3\frac{1}{2}$ second point and the end of the slide; some cases did occur, however, as in example 9, of confusion being due to a brief gap in responding at about the $4\frac{1}{2}$ second point.

Two further points about Subsequent responses should be noted. Firstly, only one Type of Subsequent response was recorded for each slide. Thus, the rule adopted for this was to regard 'PE' responses as predominant over 'E' responses, and 'C' over 'S'; where, therefore, two of these occurred on the same slide, the 'predominant' one was recorded. It may be noted that 'E' responses were nearly always present when 'PE' responses occurred. Secondly, the above classification accounted for all types of Top response observed.

We have now examined the methods used for transcribing the videotape recordings and those for classifying the transcriptions into classes of Bottom, Top and Subsequent responses, each with a number of sub-categories. We must now mention the numerical means by which these classifications were used to describe children's performance.

A straightforward way of describing children's performance would be to count up the number of slides upon which a child made a certain class of response during a session. For example, a child may have made a Top response of Type TB on 18 slides during a session of 36 slides; another child may have made such a response on all 36 slides. This method would be useful, particularly for Top and Subsequent responses, but not nearly so meaningful for responses associated with the lower response panels of the Touch Tutor, since each response could be described by a number of 'hypotheses'. An alternative way of describing Top and Subsequent responses would be to attempt more exact quantification of them to include the duration of each response and the number of such responses which occur on each slide. This last method would, however, be difficult to perform and would not seem to be justified by the hypotheses so far held about the nature of these responses. Also, in the case of the duration of such responses, there would be insufficient accuracy in the transcriptions to make an attempt meaningful.

One way of describing children's performance with respect to the response panels of the machine on their first response to such panels after the appearance of a slide would be to count up the number of successive instances of a particular 'hypothesis' until they began to indicate the presence of some pattern or 'habit' of response. Fellows has suggested (1968) the use of a run of 6 consecutive instances of a response habit as the minimum for postulating the existence of a 'habit' of responding, anything less than that suggesting the mere operation of chance A numerical score might be given from this, with a score of '1' indicating a run of 6 consecutive instances, a score of '2' indicating a run of 7, and so on.

This method was adopted for the present Results. A problem, however, arises with it if a child should break a run by one or two responses – when the question arises of whether counting should continue cumulatively after the run or should begin afresh. The latter course was believed the more legitimate and was adopted for the present Results. It may be noted that the probability of a consecutive run of 6 correct responses where p.(correct) = p.(incorrect) = $\frac{1}{2}$ is 0.016.

Finally, during Experiments 2, 2a and 3, an event recorder was used as a means of providing a basic record of responding in the event of videotape malfunction. The device was able to record the occurrence of each first response to the lower panels of the machine and to which panel it had been made.

(3) Results

(i) The Effects of the Introductory Instructions

Tables 7.1 and 7.2 indicate, for the sessions of Experiments 2 and 3, the numbers of slides upon which children made responses to the Top panel of the Touch Tutor. Table 7.1 indicates the number of slides upon which Top responses of all kinds were made; Table 7.2 indicates the breakdown of these into the three kinds of Top response which could be distinguished.

It will be observed from Table 7.1 that Top responses were made, on average, to approximately 63% of slides in each session, although the number rose in the second session for Redcourt children to approximately 80%. A similar rise did not occur during Experiment 2, where the mean number of Top responses remained similar throughout the five sessions.

Table 7.1

Number of slides upon which Top responses of all types occurred during Experiments 2 and 3.

(Experiment 2) Stallington

Session	1	2	3	4	5
Mean	21.46	23.17	24.25	26.22 *	23.30
S.D.	12.69	12.84	13.81	13.17 *	14.91
n.	13	12	12	9 *	10

(Experiment 3) Redcourt

Session	1	2
Mean	21.28	30.23
S.D.	12.72	8.51
n.	14	13

* Data of two children 'lost' through videotape malfunction.

Referring now to Table 7.2, the reader will observe that responses to Type TB were more frequent than responses of other types, occurring on between one half and two thirds of the slides in each session, for both samples. Some increase in the mean number of TB responses during both Experiments is apparent, with no similar increase in the numbers of BT and B..T responses occurring. It will be noticed that the number of children who made at least one Top response of each Type during each session was high: as the means, particularly of BT and B..T responses, suggest, however, there were cases of children making just single responses of one Type during a session. Equally, of course, as the high standard deviations suggest, some children showed marked preferences for responses of certain types during a session, therefore having a markedly higher score on that type than other children during the session.

If the reader is interested in the idiosyncratic response patterns of the children who took part in Experiments 2 and 3, he should turn to Appendix 3 where he will find the raw scores of children on each type of Top response. He will there be able to see the extent to which children did show preferences for particular types of Top response and how these changed as the Experiments continued. Briefly surveying these data here, in the Stallington sample, three children (M.W., D.P., & M.K.) made infrequent responses throughout the Experiment to the Top panel, while some 5 children made Top responses on the majority of the slides of each session. Of these five children, 3 (V.W., H.H., & A.E.) children responded throughout the Experiment with a marked preference for TB responses;

of the two remaining children, one (J.H.) began with an equal preference for TB and BT responses but ended with a preference for TB responses, while the other, (S.H.), during the three trials for which he took part in the Experiment, changed from a preference for B..T responses to one for BT responses. The remaining children showed even mixtures of the different types of Top response, but some preferences, mainly for TB and BT responses, occurred particularly towards the end of the Experiment.

Table 7.2

Number of slides during Experiments 2 and 3 during which Top responses of three Types were made; and the number of children (n.c.) making at least one Top response of each Type during each session.

(Experiment 2) Stallington

Session		1	2	3	4	5
Type of Top response:		n.=13	n.=12	n.=12	n.=9*	n.=10
TB	Mean	12.46	13.08	15.58	19.89*	18.20
	S.D.	12.53	12.89	13.89	14.15*	15.92
	n.c.	10	9	10	7*	7
BT	Mean	6.15	7.83	6.75	5.67*	4.00
	S.D.	4.99	9.05	6.72	8.06*	7.40
	n.c.	11	8	9	5*	5
B..T	Mean	2.85	2.25	1.92	0.67*	2.75
	S.D.	5.27	2.74	3.30	0.82*	1.78
	n.c.	7	5	6	4*	4

(Experiment 3) Redcourt

Session		1	2
		n.=14	n.=13
TB	Mean	11.64	18.08
	S.D.	12.66	13.57
	n.c.	12	13
BT	Mean	7.28	9.46
	S.D.	9.24	9.64
	n.c.	13	13
B..T	Mean	2.36	2.69
	S.D.	2.50	3.62
	n.c.	9	9

* Data of two children 'lost' through video malfunction

The patterns of Top responding which occurred in the Redcourt children were rather similar to those of Stallington children. Some children showed very few Top responses of any type, others showed preferences for TB responses, two showed preferences for BT responses and some children showed no marked preference for any type of Top response. One feature of the data for these children was the existence of marked increases in five children in TB responses during the children's second sessions.

It is interesting to compare these complex and idiosyncractic patterns of Top responding with the responses of the children from the 'Flaxley' school who took part in Experiment 2a. In this sample of normal children only one child made no responses at all to the Top panel of the Touch Tutor, while the remaining children made either 35 or 36 Top responses in a series of 36 slides. All the children showed a marked preference for one type of Top responding, with very few mixtures of responding occurring. Although preferences were shown for both BT and TB responses, only three children preferred BT responses, while all the remainder preferred TB responses. No instance of B..T responding occurred. Thus, responding was not only, on the whole, simple, with children showing marked preferences for one type of Top response but it was, in the majority of children, as demonstrated by E.

The results obtained with these children of normal ability emphasize the seeming lack of control exercised by the Introductory Instructions over the S.S.N. children's responding in the early stages of the Experiment. There is a suggestion from the Results that this control increased as Experiments 2 and 3 continued, inasmuch as the Top responding of type TB increased towards the end of Experiment 2 and in the second session of Experiment 3, but this was only in the case of a few children. It would, therefore, seem that the demonstration of Top responding was of limited value to the groups of S.S.N. children as wholes, in that Top responses were made, on average, to only 60% of slides in each session, approximately, and in that, if they were made, they were not necessarily made in the manner demonstrated by E., the variant types of BT and B..T responses accounting for approximately one third to one half of all Top responses made.

The aim of inducing children to touch the Top panel of the machine before the bottom ones was to help them to make correct responses. It is, therefore, interesting to discover whether correct responses were made more often after Top responses, particularly of Type TB, than after no response to the Top panel had been made on a slide.

Table 7.3 shows a breakdown of the Top responses made during Experiments 2 and 3 into those made on slides on which a correct response was made and those on which a correct response was not made.

Table 7.3

The number of slides upon which Top and Correct responses occurred during Experiments 2 and 3.

Experiment 2 (Stallington)

		Top responses		Not Top responses	
		Correct	Incorrect	Correct	Incorrect
Session 1	Mean	14.61	6.85	7.54	7.00
n.=13	S.D.	11.83	5.39	6.63	6.79
Session 2	Mean	15.58	7.50	7 50	5.42
n.=12	S.D.	11.49	5.99	7.09	6.70
Session 3	Mean	18.17	6.08	6.58	5.17
n.=12	S.D.	12.94	4.94	7.85	7.25
Session 4	Mean	21.44	4.89	5.67	4.00
n.=9*	S.D.	14.07	6.07	7.13	6.31
Session 5	Mean	21.10	2.20	6.70	6.00
n.=10	S.D.	12.20	2.44	7.50	7.52

* Data of two children 'lost' through videotape malfunction.

Experiment 3 (Redcourt)

		Top responses		Not Top responses	
		Correct	Incorrect	Correct	Incorrect
Session 1	Mean	13.14	8.14	5.28	5.78
n.=14	S.D.	9.74	4.94	5.77	5.02
Session 2	Mean	19.69	10.54	2.92	2.85
n.=13	S.D.	8.84	5.80	4.05	4.55

Table 7.3 shows that Top responses, when they were made, were not always associated with correct responses to the lower panels of the Touch Tutor. Rather, approximately one third of them were associated with incorrect responses. On the other hand, the results show that rather more correct responses than incorrect responses were made when Top responses were made, than when they were not made. Therefore, although one is led to doubt that Top responses did generally have the desired effect of encouraging correct responses, there would seem to be some association of such responses with correct responses.

Since some Top responses (types BT and B..T) were made after responses to the lower panels, one might imagine them to be less likely to be associated with correct responses than responses to type TB, which were made before responses to the lower panels. Table 7.4 shows the breakdown of Table 7.3 into the three types of Top responding and the numbers of correct and incorrect responses which were made in conjunction with them.

Table 7.4

The number of slides upon which three types of Top response and Correct responses occurred during Experiments 2 and 3.

Experiment 2 (Stallington)

Type of Top response		TB		BT		B..T	
		Correct	Incorrect	Correct	Incorrect	Correct	Incorrect
Session 1	Mean	10.23	2.23	3.15	3.00	1.23	1.61
n.=13	S.D.	12.03	2.89	3.06	2.69	2.89	2.47
Session 2	Mean	11.33	1.83	3.67	4.00	0.58	1.67
n.=12	S.D.	12.26	2.30	4.03	4.95	1.19	2.10
Session 3	Mean	13.33	2.25	4.58	2.17	0.25	1.67
n.=12	S.D.	12.60	3.63	6.09	1.52	0.60	3.27
Session 4	Mean	17.44	2.55	4.00	1.67	0.00	0.67
n.=9*	S.D.	13.90	5.21	7.38	1.94	0.00	0.82
Session 5	Mean	17.70	0.50	3.10	0.90	0.30	0.80
n =10	S.D.	15.82	0.92	7.12	0.77	0.64	1.21

* Data of two children 'lost' through videotape malfunction

Experiment 3 (Redcourt)

Type of Top response		TB		BT		B..T	
		Correct	Incorrect	Correct	Incorrect	Correct	Incorrect
Session 1	Mean	8.64	3.57	3.57	3.71	0.93	1.43
n.=14	S.D.	10.30	5.04	5.73	3.81	1.58	1.50
Session 2	Mean	13.46	4.62	4.92	3.54	1.31	1.38
n.=13	S.D.	11.64	6.02	5.74	4.40	1.94	1.98

A constant and clear tendency for responses of type TB to be more frequently associated with correct, rather than incorrect responses, and for responses of types BT and B..T not to be associated, will be observed in Table 7.4. As Experiment 2 progresses, however, approximately twice as many correct responses as incorrect responses are made in association with BT responses. The data suggest that although the two samples of children are similar in this association of correct and incorrect responses with Top responses, Stallington show a stronger association than do Redcourt.

A useful summary statistic for these data is the correlation coefficient. In Table 7.5 correlation coefficients between Top responses of all kinds and the total number of correct responses made during each session, and between Top responses of type TB and correct responses are presented.

Table 7.5

Spearman rank order correlation coefficients (r_s), corrected for ties, between Top responses and correct responses and between TB responses and correct responses during Experiments 2 and 3

Experiment 2 (Stallington)

		All Top responses		TB responses	
		r_s	p.*	r_s	p.*
Session 1	n.=13	+0.68	0.01	+0.77	0.01
Session 2	n.=12	+0.57	0.10	+0.76	0.01
Session 3	n.=12	+0.66	0.02	+0.64	0.05
Session 4	n.=9**	+0.82	0.01	+0.61	0.10
Session 5	n.=10	+0.97	0.001	+0.94	0.001

Experiment 3 (Redcourt)

	All Top responses		TB responses	
	r_s	p.*	r_s	p.*
Session 1 n.=14	+0.66	0.02	+0.63	0.02
Session 2 n.=13	+0.47	0.20	+0.51	0.10

* All probabilities given are for a two-tailed test. The levels shown are the minimum probabilities of occurrence of the correlation coefficients.

** Data of two children 'lost' through videotape malfunction.

Table 7.5 shows the existence of significant positive correlations between Top and Correct and between TB and Correct responses for the majority of sessions of Experiment 2 and for Session 1 of Experiment 3. The strengths of the correlations of all Top responses and TB responses with correct responses are generally similar, although some differences are apparent. Redcourt seems to show slightly less correlation of these variables than Stallington.

The correlation coefficients for the variables BT and B..T and Correct responses suggested no association of these variables, the values of these ranging from approximately +0.20 to -0.20. Similarly, B..T and Correct responses were not corrrelated.

These data have not indicated individual modes of response in relation to these variables. Table 7.6 provides some information on the behaviour of individual children with respect to the association of Top responding of the various types and correct responding. The Table shows the performances of children which seemed to show a significant difference[(1)] in the numbers of correct and incorrect responses made in conjunction with Top responses.

(1) The writer had quite lengthy discussion with mathematicians and statisticians about the legitimacy of applying statistical tests to the successive output of individual subjects. They argue that, by the very fact of responses being made by the same subject, the data to which a test would be applied would violate the assumption of independence of observations which underlies such tests. The writer maintained, in these discussions, that although such data must necessarily have certain features in common, by virtue of being emitted by the same person, successive responses may be thought of as random in relation to particular stimuli,

Table 7.6

Top responses associated with correct and incorrect responses during Experiments 2 and 3

Experiment 2 (Stallington)

Session	1	2	3	4	5
	n.=13	n.=12	n.=12	n.=9*	n.=10
J.B.		B..T(I)			BT(C)
V.W.	TB(C)	TB(C)	TB(C)	TB(C)	TB(C)
ED.			TB(C);BT(C)	TB(C);BT(C)	TB(C)
J.H.	TB(C)	TB(C)	TB(C)	TB(C)	TB(C)
A.E.	TB(C)	TB(C)	TB(C)	TB(C)	TB(C)
S.H.			BT(C);B..T(I)	-	-
M.J.	BT(C)	-	-	-	-
D.C.	TB(C)	TB(C)	TB(C)	TB(C)	TB(C)

Total 'countable'(1) cases in whole sample:

Response type:		1	2	3	4	5
	TB	7	7	7	7	6
	BT	6	6	5	2	2
	B..T	2	3	1	0	0

* Data of two children lost through videotape malfunction

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and hence independent. He adopts this position here, arguing that it is reasonable to look upon the distribution of correct and incorrect responses in a number of instances of Top responses in binomial terms where p.(correct) = p. (incorrect) = 0.50; and that the Binomial Test may, therefore, be used to assess the probability of given numbers of incorrect and correct responses occurring by chance. In Table 7.6 (and in Table 7.9, in which a similar argument is used to assess the correspondence of Subsequent and correct responses) correct or incorrect responses are regarded as having particular association with Top responses if, on the Binomial Test (Siegel, op. cit. pp.36-42) the two-tailed probability of a number of correct and incorrect responses occurring by chance is equal to or less than 5%. The minimum number of Top responses to which the Binomial Test can be applied is 6; 'countable' instances are therefore those of at least 6 Top responses in a session.

Table 7.6 (continued)

Experiment 3 (Redcourt)

Session	1	2
	n.=14	n.=13
H.S.	TB(C)	-
R.C.	TB(C)	TB(C)
A.R.		TB(C)
P.J.		TB(C)
C.L.		TB(C)

Total 'countable'(1) cases in sample:

Response type:	TB	6	10
	B.T.	5	7
	B..T	3	2

Key: Letters outside brackets denote type of Top responding. Letters inside brackets denote whether Correct (C) or Incorrect (I) responses were significantly(1) more frequent during a number of Top responses.

Table 7.7 shows systematic, individual patterns of Top and correct responding with 4 Stallington children showing significant associations of correct and TB responding in each of their sessions, one child showing such association in the last three sessions and most of the remaining Stallington children showing no such associations. Only two instances of incorrect responses being significantly associated with incorrect responses occurred and, when they did occur, they were in connection with B..T responses. Few occasions of BT responses showing an association with correct responses occurred, although, for the first three sesions, almost as many countable instances of them occurred as occurred of TB responses.

In the Flaxley sample, as has been remarked, nearly all the children made responses of type TB on all slides. Not all the children, however, made correct responses on these slides. Of the 24 children who made 35 or 36 Top responses (of all types) in a session, 9 of them made 22 or fewer correct responses; of the 19 children making 35 or 36 TB responses, 5 made 22 or fewer correct responses. Such high Top responding without concomitant correct responding was not so marked a feature of the responding of S.S.N. children in general; there were, however, some cases of such independence of Top and correct responding, notably in one child (S.H.) durin g the first session of Experiment 2, in two children during both sessions of Experiment 3 (C.B, and A.G.)and in two children during Session 2 of that Experiment (B.W. and R.F.).

Before leaving this discussion of the effects of the introductory Demonstration by E. upon the children's responding we must briefly note the effect of the two different conditions of this Demonstration during Experiments 2 and 2a upon the extent of touching each of the response panels in turn.

The number of slides upon which children touched the Left, Top and Right panels at least once, in any order, were noted (see Appendix 3) and the data analyzed by the Mann Whitney 'U' Test. No significant differences ($p. < 0.05$, 2 tailed) occurred during any session of Experiment 2 (Session 4 was not analyzed owing to the lack of data for two children) nor during Session 1 of Experiment 2a.

It is, therefore, concluded that this type of responding was unaffected by demonstration with two-choice, rather than one-choice slides and that, on this basis, this particular aspect of responding was not primarily due to the use of one-choice slides for instruction.

Summarizing this section of the Results, two main aspects of Top responding have been discussed relating, firstly, to the extent of Top responding in its different types and, secondly, to the relation of such responding with correct responding:

(1) Top responses were not a feature of all slides completed by either Redcourt or Stallington children, occurring on approximately 60% of slides in each session of Experiments 2 and 3. Top responses of the type demonstrated by E. ('TB' responses) occurred more frequently than variant types by the latter accounted for approximately one third of all Top responses made. The grouped data hid idiosyncratic patterns of responding in which children showed variations in the number and type of Top responses they made. Normal children in the Flaxley sample showed more frequent Top responding than the S.S.N. children in the Stallington and Redcourt samples, with marked preferences for one type of Top responses, rather than for a mixture of types. Many preferred TB responses to other types.

(2) Top responses, when they were made, were not always associated with correct responses to the lower panels, and neither were Top responses of type TB. However, Top responses were more often associated with correct responses than with incorrect responses, in comparison to those slides upon which no Top response had been made. Closer examination of the association of different types of Top responses revealed that only TB responses were more often followed by correct than by incorrect responses, however, responses of types BT and B..T being, general, as equally often associated with correct as with incorrect responses. Correlation coefficients were computed for Top responses of all kinds and correct responses, for TB responses and correct responses and for BT and B..T responses and correct responses. Significant positive correlations existed between Top and TB and correct responses, for the majority of sessions of Experiment 2 and for the first session of Experiment 3, but no correlation between BT and B..T and correct responses was found. Examination of Top and correct responding for individual children gave a similar picture to that given by the grouped data, and added to it the fact that 4 children in the Stallington sample showed associations of TB and correct responding over the whole of the Experiment. Data from the 'Flaxley' children were once again considered. Although many of these children showed a strong association of correct and Top respnses of all kinds and Top responses of type TB, approximately one third of the children responding with Top responses on practically all their slides did not respond with correct responses on them all.

Finally, giving children introductory demonstrations of responding with two-choice rather than with one-choice slides had no effect upon their touching of each panel in turn. It was concluded that this aspect of responding was not primarily caused by the use of one-choice slides for instruction in the use of the Touch Tutor.

(ii) <u>Repeated ('Subsequent') Touching of the Touch Tutor's panels</u>.

The aim of this section of the Results is to provide data concerning, firstly, the occurrence of the behavior of 'repeated touching' and, secondly, the circumstances of occurrence of this pattern of responding in relation to aspects of the Touch Tutor's mode of operation. Repeated or 'Subsequent' responding has already been defined and four 'types' distinguished.

Table 7.7 shows the occurrence of Subsequent responses of all kinds in each of the sessions of Experiments 2 and 3; Table

7.8 shows the breakdown of these totals into the four main types of Subsequent response.

Table 7.7

Numbers of slides upon which Subsequent responses of all types were made in Experiments 2 and 3 and the numbers of children (n.c.) making at least one Subsequent response during each session.

Experiment 2 (Stallington)

Session	1	2	3	4	5
	n.=13	n.=12	n.=12	n.=9*	n.=10
Mean	20.85	16.92	13.17	8.11*	10.50
S.D.	12.78	11.29	9.54	8.32*	10.28
n.c.	11	10	11	7*	9

Experiment 3 (Redcourt)

Session	1	2
	n.=14	n.=13
Mean	19.86	22.38
S.D.	12.61	12.31
n.c.	14	13

* Data of two children lost through videotape fault.

Table 7.7 shows the widespread occurrence of Subsequent responses in both samples with such responses occurring, on average, on approximately half the slides and being shown by the majority of children. A marked similarity between the two samples in terms of the number of Subsequent responses made exists at the beginning of each Experiment, although the similarity lessens somewhat in the second sessions. A decrease in Subsequent responding is apparent in the Stallington children as Experiment 2 proceeded.

Table 7.8 shows that the decrease in Subsequent responding which was apparent during Experiment 2 occurred in all the types of responding. Similarly, the increase in Subsequent responding which occurred in the Redcourt children's second session included increases in all the types.

Throughout Experiment 2 responses of type 'E' were the most frequently displayed, while responses of type 'S' on the whole enjoyed second place in frequency of occurrence. The Redcourt data are rather dissimilar, showing a higher occurrence of type 'S' responses and a lower occurrence of type 'E'.

Table 7.8

Number of slides during Experiments 2 and 3 upon which instances of four types of Subsequent responding occurred and the numbers of children (n.c.) showing at least one instance of such responding.

Experiment 2 (Stallington)

Session		1	2	3	4	5
		n.=13	n.=12	n.=12	n.=9*	n.=10
Type 'S'	Mean	4.62	4.08	4.25	2.89*	2.20
	S.D.	7.53	5.45	3.47	5.09*	2.44
	n.c.	8	9	10	6*	5
Type 'E'	Mean	7.46	9.58	6.75	4.11*	4.50
	S.D.	8.10	10.43	6.43	5.61*	7.09
	n.c.	9	9	10	5*	6
Type 'PE'	Mean	5.23	1.83	0.17	0.00*	1.20
	S.D.	8.85	4.12	0.55	0.00*	3.60
	n.c.	4	2	1	0*	1
Type 'C'	Mean	1.62	1.08	0.75	0.33*	2.00
	S.D.	2.56	1.44	0.92	0.67*	2.68
	n.c.	6	5	6	2*	5
'Other'	Mean	1.92	0.33	1.25	0.78*	0.60
	S.D.	2.62	0.74	2.49	1.87*	1.80
	n.c.	7	2	3	2*	1

Experiment 3 (Redcourt)

Session		1	2
		n.=14	n.=13
Type 'S'	Mean	12.93	14.54
	S.D.	10.33	11.45
	n.c.	14	13
Type 'E'	Mean	2.86	4.62
	S.D.	2.85	5.82
	n.c.	10	10
Type 'PE'	Mean	0.43	0.62
	S.D.	1.29	1.42
	n.c.	2	2
Type 'C'	Mean	0.71	0.92
	S.D.	1.16	1.14
	n.c.	5	6
'Other'	Mean	2.93	1.69
	S.D.	3.71	1.59
	n.c.	10	9

* Data of two children lost through videotape fault.

These two Tables provide a useful summary picture of the frequencies of Subsequent responding. Of course, they do not show changes in the responding of individual children over time nor the combinations of the different types of responding which children adopted. As was the case for Top responding, it is not proposed to devote much space here to a description of the performance of individual children. Nevertheless, it is of interest to consider the behaviour of some of the children individually.

In the Stallington sample, two children (M.K. and D.C.) made virtually no Subsequent responses throughout the Experiment. Many of the remaining children made a mixture of types of Subsequent response, although there were often preferences for one or two types in comparison to the others. Some children showed marked preferences. Thus, M.W. preferred 'E' responses throughout the Experiment, making these on approximately half the slides in each session and making few responses of any other type. V.W. similarly preferred 'S' responses, while D.P. and H.D. preferred 'PE' responses. In the case of these last three children, however, this preference was strong only at the beginning of Experiment 2, dropping from 22 to 2 responses in the case of V.W. and changing to preferences for 'E' responses in the case of H.D. and D.P.

In the Redcourt sample, a similar picture of children showing a mixture of types of Subsequent responses, but with marked preferences, occurred. As is suggested by Table 7.8, however, children tended to prefer 'S' responses. No child showed marked preferences for 'E' responses over any other type, except in the second session when two children showed such preferences, and few instances of 'PE' and 'C' responses occurred. All children showed at least one instance of Subsequent responding.

The overall picture presented by these data is one of complexity. These children made responses to the panels of the Touch Tutor which were not essential (although the children may have believed that they were) for its operation on, for average, approximately half the slides in each session. Moreover, these responses were not clear-cut ones, but were ones which have presented extreme problems of classification.

Faced with this problem of diverse pattern, some necessity for 'explanation' may be felt. Why these S.S.N. children should exhibited 'Subsequent' responses, in such diversity, would seem an important question.

The classification system adopted for these responses arose primarily from inspection of the transcribed records. It also, however, bore some correspondence to the Touch Tutor's mode of operation, with some responses ('S' responses) corresponding to the period of a few seconds from a touch to the response panels of the machine to the machine speaking and some ('E' responses) ending as the slide changed. One could, therefore, hypothesize that these events were 'controlling' Subsequent responses, rather in the way that the click of a light switch and the subsequent appearance of the light terminates the action of operating the switch by signifying that the response has been 'effective'.(1) To test such an hypothesis one would need to consider the extent to which children's Subsequent responses were associated with certain stimulus events. Let us now do this for the present data.

One could expect, were it the case that the stimulus event of the machine speaking were an important determinant of Subsequent responses, that responses of types 'S' and 'E' would be respectively confined to slides upon which correct and incorrect responses had been made. Inspection of the results revealed that such a state of affairs did not generally exist. Most of the Subsequent responses of these types which children made were divided equally between correct and incorrect responses. There were some occasions, however, when it seemed that such responses were being made only in conjunction with correct or incorrect responses. Table 7.9 shows when such occasions(2) occurred and with which types of Subsequent response they were associated.

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(1) It is interesting that University students, and adults and children seeing the Touch Tutor on 'Open Days' have often, if asked to 'make the machine speak', shown similar response patterns to those which these S.S.N. children have adopted. Such people were apparently searching for the way to 'make it work' for the simple command: 'Just touch the panel once', if understood, would often remove these patterns completely. Asked about their behaviour, such people had usually been looking for whatever 'switch' operated the machine and, being unable to locate it, had been encouraged to persist in some responses by the contingent operation of the machine on some of these responses. Unfortunately, the only obvious 'reaction' of the machine in such cases was either the slide-change or the machine speaking and so these (and not the detection of a touch by the machine) became the reinforcement - 'evidence' that a touch had caused the machine to operate.
(2) See footnote on pp. 171,172.

The presence of a performance in the Table may be taken as meaning that a significantly different ($p. < 0.05$, two-tailed) number of correct and incorrect responses (on the Binomial Test) were associated with Subsequent responses of a particular type. Occasions when children responded with at least six instances of a type of Subsequent response without showing a significant preference for correct or incorrect responses are also shown in the Table.

Table 7.9

Subsequent responding of types 'S' and 'E' associated with correct and incorrect responding in Experiments 2 and 3.

Experiment 2 (Stallington)

Session	1	2	3	4	5
	n.=13	n.=12	n.=12	n.=9*	n.=10
M.W.	E	E	E(I)	E(I)	E(I)
J.B.	E(I)	E(I)	E	E	
V.W.	S	S	S		
P.D.	S;E(I)	E(I)			
J.H.	E	E	E(C)		S
H.H.	S	S(I)	S	S	-
A.E.	S				
S.H.	S	S(I)		-	-
M.J.	E	-	-	-	-
H.D.		E	S;E(I)	*	S
D.P.	E(C)	E	S;E(I)	*	E

Experiment 3 (Redcourt)

Session	1	2
	n.=14	n.=13
R.C.	S(C)	S(C)
S.G.	S(C);E	S
M.W.	S	S
A.R.	S	
P.J.	S	S;E
R.W.	S;E	E
B.W.	S(I)	S(I)
C.B.	S	S
R.F.		S
S.B.		E
C.M.	S	S

* Data of two children lost through videotape fault.

Table 7.9 (continued)

Key: Letters outside brackets denote type of Subsequent responding associated with a significant (see text) difference between correct and incorrect responses. Letters inside brackets denote whether Correct (C) or Incorrect (I) responses were the more frequent. Letters standing alone indicate the existence of six or more responses of a particular type during a session.

Table 7.9 suggests that there were occasions when Subsequent responses of types 'S' and 'E' might have been influenced by whether the machine had spoken or not. In the majority of cases the apparent effect of the machine speaking was in the predicted direction; that is, that 'E' responses more often followed Incorrect than Correct responses and that 'S' responses were more accompanied by Correct than by Incorrect responses. Notably, however, exceptions occurred - for example, in the performances of J.H. (Session 3), D.P. (Session 1) and B.W.- when the associations were reversed.

In general, although there were occasions when 'S' and 'E' responding was associated with correct or incorrect responding, there were sufficient instances when no such association was evident for us to doubt that the machine speaking was a general cause of these Subsequent responses. Stallington children produced 15 instances during Experiment 2 of 'S' responding of six or more slides per session,of which only two showed a significant association and 21 instances of 'E' responding, of which 11 showed any association. Redcourt children showed 17 instances of 'S' responding, of which 5 showed any significant association and 5 instances of 'E' responding of which none showed an association. Moreover, some of these significant associations were not in the expected direction. Therefore, although these data offer some evidence towards the belief that an important determinant of 'E' and 'S' responses was the machine speaking the generality of this belief is questionable.

Turning now to the event of the slide-change, it is clear that this was generally effective in controlling responding. Only 10 instances of 'PE' responding occurred in Experiments 2 and 3 and these were confined to five children, two of whom made five or fewer such responses in each session. The remaining children in the samples made no responses after the slide had disappeared. Interestingly, one child (M.J.) made 13 out of 14 'PE' responses after incorrect responses in the one session he spent in Experiment 2.

Commenting, lastly, on type 'C' responses, the impression one gained from watching some of the children was that such responses were being made when children were waiting, after a response, for the slide to change and, having come suddenly to the idea that their touch had been ineffective in triggering the mechanism of the machine, they would touch the panels once more. It would, however, be difficult to test this belief about the nature of 'C' responses, so that it must be taken only as a suggestion about such responses, in the absence of a more satisfactory explanation of them.

Summarizing this section of the Results, it has been shown that Subsequent responses occurred on approximately half the slides completed by children in Experiments 2 and 3. Most of these responses were of types 'S' and 'E', but individual preferences for other types did occur. In some cases it seemed that 'S' and 'E' responses were associated with either correct or incorrect responses but many instances of such responses occurred which showed no such association. The low occurrence of 'PE' responses suggested the effectiveness of the slide-change in controlling responding. Responses of type 'C' were briefly discussed.

Before leaving Subsequent responses mention should be made of the extent of such responding in the Flaxley sample . As might be expected Subsequent responding was very much simpler in these children. Of the 25 children studied 11 made no Subsequent responses whatsoever and 8 made 1 or 2 responses (usually of types 'S' and 'E') during their first session. Of the remaining 6 children, 4 made responses on 34-36 slides of one particular type (3 chose 'S' responses and one chose 'PE' responses), one responded with a mixture of 16 'S', 12 'E' and 6 'O' responses and one responded with 18 'S' responses. Thus, mixtures of types of Subsequent responses were rare and Subsequent responses seemed either to be adopted wholeheartedly or not at all by a child. In only one child was it apparent that Subsequent responses were particularly associated with correct or incorrect responses when all his 18 'E' responses were made after incorrect responses. In children who had second sessions marked change in Subsequent responding was noticeable only in one child, who made 36 'PE' responses during his first session and 36 'E' responses during his second session.

(iii) Response patterns associated with children's first responses to the lower panels of the Touch Tutor on the appearance of a slide.

In presenting data concerning Top and Subsequent responses measures of the occurrence of these responses were based upon the number of slides upon which they were noted. the present type of response pattern this measure would be cumbersome, since each response made by a child would simultaneously score on three types of pattern. Therefore, use will be made here of 'habit' scores. These have already been described (see page 164) and it may be remembered that only consecutive instances of particular types of response were to be counted, with counting beginning on the sixth consecutive instance of a type of response. In Table 7.10, which shows the presence of such 'habits' during Experiments 2 and 3, the numbers indicate the total habit scores for each session; also shown is the numbers of separate runs which went to make up this total score.

Table 7.11 shows the re-classification of the data contained in Table 7.10 to enable a clearer impression to be gained of the relative frequencies of occurrence of the different types of response pattern.

Tables 7.10 and 7.11 show that 'Matching' and 'Position Perseveration' were the most widely displayed patterns in both Experiments, with 'Win-Stay, Lose-Shift' coming far behind in third place. Not only were these patterns adopted by more children, but they were adopted with greater strength. It can be seen that Matching enjoyed an increase both in strength and in the number of children adopting it as the Experiment continued for the Stallington sample, while Position Perseveration suffered a decline.

Some children showed persistent adherence to a particular response pattern both during individual sessions and during the Experiments (e.g. M.W., M.K., and D.C. in Stallington; and A.G. in Redcourt); other children showed mixtures of response patterns during sessions (e.g. V.W., P.D. and J.H., Session 2, Stallington; and S.G., M.W., Session 1, Redcourt) and during the experiments (e.g. J.B., V.W., Stallington; and A.R., Redcourt).

Stallington and Redcourt were similar in their adoption of these response patterns, showing similar preferences for Matching and for Position Perseveration habits, and similar mixtures of habits. In both samples, the widespread occurrence of patterns of one kind or another was noticeable - all children showed some response patterning during each Experiment.

All the children in the Flaxley sample except three displayed habit scores of 15 or more and no instance s of mixtures of habits occurred. Position Perseveration was adopted by 6 of the 25 children, Position Alternation by one child and Win-Stay, Lose-Shift by one child. The remainder adopted Matching.

Table 7.10

Total habit scores of children during Experiments 2 and 3 (and the number of separate habit runs).

Experiment 2 (Stallington).

Session	1	2	3	4	5
M.W.	PP30(1)	PP30(1)	PP28(1)	PP30(1)	PP30(1)
J.B.	W2(1)	PP1	M19(2) W4(1)	M4(2) W6(2)	M10(2)
V.W.	PP5(2)	M11(2) PP7(2) W2(1)	M2(2) PP3(1)	M30(1)	M25(2)
P.D.	PP9(1)	PP5(2) O2(1)	M22(2)	M25(2)	M25(2)
J.H.	M5(2) PP1 W1	M7(2) PP2(1)	M17(2)	M12(3)	M15(2) PA4(1)
H.H.	PP6(3)	PP5(1)	PP4(2) PA1	PP9(2)	-
A.E.	M19(3) PP2(1)	M19(3)	M14(1) PA1	M13(3)	M25(2)
S.H.	PA5(3)	PP5(1)	PP1 W4(1)	-	-
M.J.	L4(1)	-	-	-	-
H.D.			PA3(1)	W2(1)	
D.P.	PP16(2) W3(1)	PP22(2)	W1	PP20(2)	PP7(3)
M.K.	PP28(1)	PP30(1)	PP30(1)	PP30(1)	PP30(1)
D.C.	M31(1)	M31(1)	M31(1)	M31(1)	M31(1)

Key: see remainder of Table on next page.

Table 7.10 (continued)

Experiment 3 (Redcourt)

Session	1	2	
H.S.	M21(1)	-	
	L1		
R.C.	M10(2)	M12(2)	
S.G.	M3(1)	PP3(1)	
	PP3(1)		
	PA1		
M.W.	M2(1)	PP1	
	PP1		
	W1		
A.R.	W4(1)	M18(1)	
		PP1	
P.J.	W1		
R.W.	PP9(3)	PP1	
	L3(1)		
B.W.	PP30(1)	PP23(1)	
		O1	
C.B.	PP30(1)	M1	
		PP5(3)	
A.G.	PP28(1)	PP27(1)	
R.F.	PP4(2)*	PP19(1)	*22 slides completed.
C.L.	**	M31(1)	**19 slides completed.
S.B.	PP3(1)***	PP4(1)	***16 slides completed.
		O1	
C.M.	PP10(2)	PP2(1)	
		M7(1)	

Key

Letters indicate type of response habit (see page 159).
Numbers outside brackets indicate strength of response habit (see text). Numbers inside brackets indicate number of separate habit runs going to make up total strength.

Table 7.11

Total strength (T.S.) of, and numbers of children (n.c.) displaying habit runs in Table 7.10

Experiment 2 (Stallington)

Session		1	2	3	4	5
Response Pattern:		n.=13	n.=12	n.=12	n.=11	n.=10
M	T.S.	55	68	105	115	131
	n.c.	3	4	6	6	6
O	T.S.	0	2	0	0	0
	n.c.	0	1	0	0	0
PP	T.S.	97	107	66	89	67
	n.c.	8	9	5	4	3
PA	T.S.	5	0	5	0	4
	n.c.	1	0	3	0	1
W	T.S.	6	2	9	8	0
	n.c.	3	1	3	2	0
L	T.S.	4	0	1	0	0
	n.c.	1	0	1	0	0

Experiment 3 (Redcourt)

Session		1	2
Response Pattern:		n.=14	n.=13
M	T.S.	36	75
	n.c.	4	6
O	T.S.	0	0
	n.c.	0	0
PP	T.S.	118	86
	n.c.	9	10
PA	T.S.	1	0
	n.c.	1	0
W	T.S.	6	1
	n.c.	3	1
L	T.S.	4	0
	n.c.	2	0

(4)Discussion

The impression gained from the data on Top responding yielded by Experiments 2 and 3 is that, in general, the Instruction procedure used to introduce children to the Touch Tutor had poor control over their responding. We do not, of course, have data obtained under conditions in which no such Instruction was given with which to assess the presence, rather than the absence, of such Instruction but it is clear that the beahviour of the S.S.N. children given the Instruction whether they were naive to the Touch Tutor (as in Experiment 3) or had had experience of it (as in Experiment 2) bore, in the majority of cases, little direct resemblance to the demonstrations of responding given by E. Instead of responding with a Top and a Bottom response in that order children often responded either with no Top response at all or with a Top response made after one or more responses to the lower panels.

Why this lack of correspondence with the demonstration given by E. should have occurred is unclear, and the writer has been able to find little discussion of observational learning, particularly with reference to the S.S.N. child, which might illuminate the problem. Some relevant discussion is, however, provided in a review paper by Aronfreed (1969).

In this paper, which is devoted largely to discussing experiments on 'imitation' in normal children, Aronfreed briefly discusses some experiments (Baer et al., 1967; Metz, 1965) with retarded and autistic children. According to Aronfreed, these experiments have shown little evidence of a representational model in such children for the imitation of observed behaviour but they have shown that such children's behaviour could have:

"A certain amount of fidelity to the general form, and sometimes the sequence, of the behavior that [the child] has observed - example, the child is required to touch its toes, to place its hands upon its head, or to pronounce and assemble cetain components of words, following the corresponding actions of the adult or puppet." (p.224)

It seemed to Aronfreed, after examining briefly which particular features of a demonstration such children might subsequently reproduce, that:

"There appears to be an initial period during which the children use observed behavior as a source of cues for trial and error learning, rather than as a representation of the behavior that they are to perform, since their ability to reproduce the necessary movements ..... at first only gradually approximates .. [the observed behavior] ....The minimal role of cognitive representation in the initial learning process is reflected in the technique of external physical guidance of the required actions which has been used by Metz(1965) and by Baer et al.(1967) as a way of helping autistic and retarded children to arrive at the point where they will reproduce the actions spontaneously." (pp.224-225)

Aronfreed later notes the difficulty animals appear to have in imitating actions:

"Even in those cases in which the animal appears to learn manipulative or sequential be .vior, the behavior is limited to fairly simple operations upon the environment, such as turning a knob or pushing a pedal. These actions do not require that the animal gives a structural representation to the topographic components of an extended pattern of observed behavior." (p.241)

In these extracts from his review paper, Aronfreed seems to be suggesting a limited nature for imitative learning in retarded children which he would attribute to limitations upon their forming an internal, cognitive representation of a particular demonstration. Animals might have a similar problem. Having seen a demonstration, children may show imitation of the general form and, sometimes, the sequence of the observed behaviour, appearing to be gaining a general impression of the task upon which to base their subsequent behaviour, however, rather than to be reproducing the demonstration exactly.

From this, it would seem likely that children in the present experiments were influenced by the demonstration given by E. From Aronfreed's discussion one would predict that the influence would probably be of a general nature, encouraging the children to touch the Top and Bottom panels, but unlikely necessarily to lead them to touch the Top and Bottom panels in that order, and unlikely to lead them to touch the matching stimulus after touching the Top panel, rather than the non-matching stimulus. Speaking of the children generally, this is what happened. But the diversity of the children's responding in each of these respects was remarkable, defying such simple explanation.

There would seem to be some value in encouraging children to point first to the Top panel of the Touch Tutor in order to encourage children to make correct responses, inasmuch as Top and Correct responding showed a positive association in the majority of sessions of Experiments 2 and 3.

One must be wary, of course, of assuming that Top responding was the cause of correct responding. Despite this association, however, it must be noted that there were many occasions, particularly in certain children, when Top responses did not necessarily lead to correct responses. Similarly, it will be remembered, the mode of machine operation employed by Hively (for his first machine) and by Bijou, in which children had to respond first to the Top panel of the machine, did not necessarily lead to correct matching to sample. Similar considerations would seem to apply also to the lack of difference between instructions with one-choice slides and with two-choice slides. These would appear to be small differences to these children, having little effect upon either their matching or upon their habit of touching each response panel in turn.

In the Introduction to the present Chapter we noted two ways of 'explaining' Subsequent responses. One regarded such responses as primarily the fault of the machine's mode of operation, coupled with ineffective teaching. The latter would cause the child to be uncertain about how to respond, causing errors; chance contingencies of reinforcement arising from the former would then strengthen particular patterns of incorrect response. One slightly contrasting way of explaining Subsequent responses was to regard them as a facet of 'exploratory' behaviour on the part of the child.

One way in which these two possible explanations are 'contrasting' is that whereas the former sees Subsequent responses as the 'fault' of the machine and programme for 'confusing' the child, the latter sees such responses as the 'fault' of the child - in originating in him and being brought to the task by him. The difference between these two kinds of explanation may, however, be more one of emphasis than of fundamental opposition to each other, for neither explanation is able to fit the data fully. The problem a reinforcement analysis must face is why children adopt different kinds of Subsequent response in the same setting; the problem for a completely 'from within' approach is why the behaviour should some regularity with respect to observable stimulus events.

As we shall see later when discussing response patterns associated with children's first responses to each slide a trade-off between stimulus and organismic events can be achieved by regarding responses as the outcome of an interaction between the direction of a child's attention (reflected by his idiosyncratic mode of responding) and the reinforcing value of the various aspects of the experimental task. Thus, Subsequent responses might have their initial form as a result of the child's previous reinforcement history of responding in similar tasks, as a result of his imitating the demonstration of E., or as a result of 'exploratory tendencies'. They might persist or change through the effects of the machine speaking and changing slides upon the patterns initially adopted by the child. Just what the particular mechanisms of this could be would, however, be a matter for further detailed analysis of these responses and this might, in view of the complexity of such responses which we have observed, have to be based much more on the long term study of individual children.

The predominance of Subsequent responses leads one to the question of how far they should be encouraged or suppressed. It is possible that they interfere with the development of correct matching performance. On the other hand we have seen matching performance develop in children who have engaged in Subsequent responding and the fact that some children have made Subsequent responses only after incorrect responses suggests that such responding may sometimes be indicative of the reinforcing value of the machine's mode of operation and that it would not necessarily detract from the development of matching. Moreover, the data of Experiment 2 suggests that continued practice helps to diminish these responses in some children; it could even, in time, lead to their disappearance. Therefore it is hard to see, except for those children who have settled down to a steady state of responding, what advantage there could be in attempting to suppress such responding, even if this could be done.

Before leaving this discussion of Subsequent responses it must be made clear that the writer is conscious of having but 'scratched the surface' of these responses. It is possible, especially if the timing of such responses were measured more precisely, that further subdivisions of 'types' could be found which would throw further light on their origins and implications. In the writer's belief these responses, which have such vast complexity (particularly in the light of the responses of children from the Flaxley sample) could be worthy of further investigation as indicators of the cognitive make-up of the S.S.N. child. Too little attention seems to have been paid to such responses, particularly by the 'operant' workers who, given that such responses are likely to be widespread in lever-pulling and similar tasks, have been guilty of over-simplification in describing the responding of these children(1).

(1)It should be mentioned that at least one paper discusses similar responses in an 'operant' task. Barrett and Lindsley (1962) presented S.S.N. children with a task in which rewards could be gained for responding

The behaviour of the children with regard to response patterns associated with first responses to the lower panels shows considerable similarity to the general outline of these responses given earlier in this Chapter (pp.145ff.) of the occurrence of such patterns in other subjects and tasks. From the results of relevant previous research it was noted that response patterns seemed to be widespread features of many organisms in problem-solving tasks, that Position Perseveration habits were the most characteristic pattern in the behaviour of very young normal children with a mental age of approximately three years and of subnormal children with similar mental ages, and that the response pattern behaviour of children at this level seemed to be largely unaffected by changes in the task such as particular instructions or reinforcement schedules. The data obtained in the present studies are similar, with response patterns occurring in the majority of children and Position Perseveration being the most widely adopted habit. It is difficult to be sure that the response pattern behaviour of these children was unaffected by the instructions; however, the inter-subject variability in behaviour suggested a general lack of experimental control over the children which leads one to suppose that, in common with the studies in the literature, such variables did have little effect.

Attempts to 'explain' such habits of responding are met by similar problems to those which beset the previous discussion of Subsequent responses. Again, one is faced with the problem of accounting for the origins of such patterns of response (i.e. why a systematic habit and not random responding?), their form and their persistence and change.

The fact that they occur at all (although they were not evident in all the children, all the time(1)) is, in view of their commonness in other experimental subjects in a variety of tasks, not surprising. What they represent when they do occur, however, is a matter for debate. Krechevsky, who conducted the first extensive examination of response habits in rats saw them as indicators of integrated problem-solving by the rat.

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differentially to two levers according to the presence or absence of stimulus lights. Acquisition of differential responding to the levers varied markedly with some children showing rapid acquisition and some children no acquisition. Idiosyncratic patterns of responding to the two levers emerged which were regarded by the authors as organismic variables which: "interfere with efficient differential response to immediate contingencies in a controlled environment." (p.434) No explanation was offered for these patterns of response, the authors considering them as: "behavioural excesses and deficiencies" (ibid.)

(1) In view of Lashley's (1929) and Krechevsky's (1935) work with rats

Certainly, it seemed to him, habits could not originate primarily in the experimental set-up, for an insoluble task in which no stimulus was systematically associated with reinforcement, animals not only developed habits but different animals developed different habits, some responding with visually-based habits and some with position-based habits (1932b). Moreover, animals would maintain a habit for so long, then abandon it and adopt a different one, an observation borne out by later experiments (1933a) in which the basis for the solution of a task was changed after animals had adopted habits, with the result that the basis for their habit was changed. The present data have something of a similar flavour, showing differences between and within subjects in the kinds of habits adopted, and in their strengths.

One cannot know with rats, and it would be difficult to find out with S.S.N. children, whether 'hypotheses', to use Krechevsky's term for response habits, actually reflect deliberate formulations of a basis for choice by the subject, or whether they operate at a rather more 'unconscious' level. Krechevsky seemed to favour the former view, referring to such behaviour as 'purposive' (e.g. 1933a, p.429) and joining with Tolman in his anti-Hullian view of learning processes in the rat.

One can avoid some of this mentalism by adopting a theory such as that proposed by Sutherland and Mackintosh. The 'free-will' of Krechevsky is largely replaced by a situation in which choices are determined by the balance of strengths of attentional and response mechanisms. As we saw earlier (pp. 150-154) this theory helps, in principle, to explain why children should adopt different habits in the same experimental set-up and why switches in habits should occur. The theory has already been described and an argument laid down on behalf of changes in the direction of children's attention at different ages. Amalgamating the two, one would perhaps have expected there to be variation in the particular form and strength of habits adopted by children near the beginning of the experiments, but with Position Perseveration being the most common. On the same basis, variations in the extent of change of habits would be expected in the course of the

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having cortical destruction it is possible that the relative absence of habits in some children could have been due to brain damage. On the other hand, there is a strong possibility that the analysis has been insufficiently fine to demonstrate the existence of habits having bases other than the three main ones, with their sub-divisions, of Stimulus-based, Position-based and Outcome-based habits.

experiments. This more mechanistic approach lends itself to quantification and prediction rather more readily than does that of Krechevsky. Given the pattern of performance at the outset of an experiment one has the possibility of attempting crude predictions of the likely changes in performance as the experiment proceeds. Thus in Experiment 2 the performances of three children (M.W.,M.K. and D.C.) seem to have been based completely upon single habits. In the terminology of the Sutherland and Mackintosh theory, this would suggest that their choice behaviour was completely under the control of single stimulus analyzers (position analyzers in the case of M.W. and M.K. and matching analyzers in the case of D.C.). Since these analyzers would consistently receive reinforcement, their extinction would be unlikely and performance would be likely to remain steady throughout the experiment (which, in fact, it did). In the Redcourt sample, A.G. also showed a consistent performance, with similar characteristics. In considering such prediction, however, it must be realized that the occurrence of Subsequent responses between first responses to a slide would affect the pattern of reinforcement. As an example of this, B.W. and C.B. in the Redcourt sample ended Session 1 with a consistent Position Perseveration habit which had been present throughout the session but which broke down subsequently in Session 2. This could well have been due to their having made Subsequent responses to other panels, unlike M.W., M.K., D.C. and A.G. who did so infrequently.

It is harder to <u>predict</u> the behaviour of the other children from the Sutherland and Mackintosh model with any exactness, owing to the complexity of the children's responding, an ignorance of the quantitative effects of the possible reinforcing events of the experimental set-up and an ignorance of the relative strengths of analyzers and response tendencies at the beginning of the experiments. An attempt may be made at <u>interpretation</u>, however.

The strengths of particular response patterns at the outset of the experiments are a crude index of the relative strengths of different stimulus analyzers. As the experiments proceeded these strengths would be assumed to be undergoing changes as a result of the correlation of responses with reinforcement eventually reaching asymptotes which would eventually be reflected in steady performance. For some children this steady state of performance would be likely to be on the basis of the matching relationship of the stimuli, since responses made on the basis of the matching relationship in the course of learning would result more often in the reinforcement arranged by E. However some children could settle to a steady state of performance on the basis of some other rewarding aspect of the task, or they might come under the control of a partial reinforcement schedule in such circumstances as, for example, if no responses to the matching relationship had been made. If, in such a circumstance, they had made responses often enough on the outputs of other stimulus analyzers these would then have become the predominant basis for choice.

The implications of this seem to be clear; continued practice in the task would be likely to be of little value to children with strong position habits but might help children who adopt a mixture of habits, or no habits at all, to settle down to one habit exclusively. If this habit is to be, however, the one desired by E. for the children to attain, the probability of the child's attending to the appropriate stimulus dimension must be increased, not decreased. Hence, some way of drawing the child's attention to, in these experiments, the matching relationship of the stimuli, would have to be found.

The approach of this Chapter has been to permit children to make errors in responding to the Touch Tutor; it has been assumed that these represent lawful, potentially explicable processes in the S.S.N. child and the errors have accordingly been studied in the hope that some of these processes may be made clearer. This approach is in direct contrast to that of the majority of previous investigators of the responses of S.S.N. children to teaching machines who have tended to regard such errors as 'bad' and who have accordingly attempted to prevent their occurrence. Which is the more 'desirable' approach depends upon one's aims. The latter has advantages in leading children to criterion performance quickly and it may minimize errors in transfer tasks, in that 'error-making tendencies' have not been encouraged. On the other hand, systematic error patterns appear to be so widespread in problem-solving that they would seem to be an essential part of the process. One may argue, therefore, that they should be encouraged in the hope that the child will reach more efficient problem-solving strategies. The present experiments have yielded little direct evidence that encouraging these strategies is beneficial but, insofar as correct matching performance with few Subsequent responses has been achieved by some children in the course of Experiments 2 and 3, it would seem that allowing errors does not necessarily lead to poor performance. Of course, this is not surprising, but exponents of 'errorless learning' may make us forget the fact.

(5) Conclusions

The present Chapter has gone some way towards evaluating the effects of the introductory instructions adopted for the Experiments upon children's responding, towards describing the behaviour of 'repeated touching' and towards describing the various patterns of response.. A striking feature of the descriptions has been the tremendous complexity of the S.S.N. children's responding to the Touch Tutor, a complexity which has illuminated the inadequacy of the machine and a fairly simple form of instruction in its use for controlling the responding of many S.S.N. children in experiments such as those described here. In addition, however, the analysis has shown a lawfulness in the children's responding which has suggested the possible value of permitting children to engage in problem solving tasks for which they would have to find their own solutions, in contrast to instructing them with carefully sequenced, programmed instruction which would reduce errors. It has been suggested that further work could valuably be aimed at response patterns in this light but, since they have appeared to be so common further work on any aspect of them in relation to the S.S.N. could have importance.

CHAPTER 8: THE USE OF THE TOUCH TUTOR IN THE CLASSROOM ("EXPERIMENT 4")

(1) Introduction

The aim of this chapter is to consider the responses of S.S.N. children (and of their teachers) to the presence of the Touch Tutor in a school classroom. The chapter considers the problems such use may raise and reports a Study ("Experiment 4") in which the machine is used by teachers in their everyday classroom teaching of the children who took part in Experiment 3.

There seem to be few studies or discussions of the problems raised for the teacher by the introduction to, and subsequent use of, teaching machines in everyday classroom settings - be they in normal or in special education. Thus it was difficult to consider the use of the Touch Tutor in classrooms in the light of previous experience. Even so, it appeared from the general literature and from personal observation by the author of classroom life that the Touch Tutor might be used by teachers in one of two broad ways. On the one hand the physical design of the classroom and the conduct of the lessons might be arranged around teaching machines, these then taking a central place in the lessons. This approach has been taken by Bijou _et al_. (1966) who built a special 'programmed classroom' in which tokens were given to 'educable' children for good study behaviours and where machines were used in booths resembling a language laboratory; by Marshall (1969) who, in an E.S.N. school, developed linear teaching programmes and appropriate programmes for the teaching of reading in classes where this had been a difficult subject to teach; and by Morgan (1970, 1971) who felt dissatisfaction at the teaching in his E.S.N. school and who therefore developed his own audio-visual teaching machines and programmes for them, around which many of the lessons in his school were arranged.

On the other hand the machine could occupy a much smaller role in classroom teaching, while nevertheless contributing to it. Skinner (1961a) and Holland (1960, 1962) emphasized the importance of discrimination training for young children and suggested that a machine similar to the Touch Tutor would be superior to a teacher in such instruction by virtue of its patient, systematic administration of reinforcement and, since it could be used for self-instruction by the pupil, by virtue of allowing the subject to proceed at his own pace. It would also, of course, permit the teacher to revise her lessons until they taught as effectively as she desired - and it would relieve her from that part of teaching which was repetitious, permitting her to spend more time on the more 'challenging' aspects of her profession. Behavioural Research and Development Ltd. (1969, 1971) have pointed to similar virtues in relation to the Touch Tutor, stressing its patience, attractiveness to the student and simple operation, which enabled it to encourage speech ("children frequently imitate the voice on the machine") and to create a stimulating environment.

Now if one has these latter aims for the Touch Tutor - that it teaches discriminations and creates a stimulating environment while encouraging speech - it is perfectly possible to look on it merely as a piece of educational apparatus or a teaching aid - admittedly a sophisticated one - but nevertheless a teaching aid exactly like, for example, a crayon. A crayon, after all, holds interest, can be used for self-instruction, helps teach discriminations (I suppose!), stimulates speech ("Look what I've drawn!" - "What is it?" - "A car"... etc.) and so on. But the crayon does not, or at least seems not to, occupy a central place in classroom life; it is part of a selection of apparatus in a school and is used as such.

One might expect, therefore, that the introduction of a piece of apparatus like this would cause minor disruption to the teachers' every-day work in contrast to that likely to be caused by the introduction of teaching machines to be used in the manner employed by the three writers cited above. In the study to be reported here of the Touch Tutor in the school of a small residential home for S.S.N. children and young adults, it was felt that minor disruption to the customary operation of the school was essential and therefore that a suitable use of the machine should be employed. Equally, however, it was felt that using a teaching machine like the Touch Tutor in a more minor role than had hitherto been attempted in classroom studies might permit the validity of some of Skinner's claims for such machines and those of the makers of the Touch Tutor to be looked at more closely than would be possible were it intended that such machines should have a major place in the conduct of lessons. It is also the case that the amount of programme material which is available for the Touch Tutor is so limited that extensive use of the machine would, on this count alone, be possible for only a very brief time. Accordingly the study to be reported in this chapter was based on the idea that the Touch Tutor might have value as a piece of educational apparatus to be used by teachers in an everyday classroom setting just as they might normally use toys, games and puzzles. The next task is to consider how such apparatus is normally used in such a setting.

(2) <u>An analysis of the use of apparatus by the classroom teacher</u>

Observations of teachers at the 'Redcourt' school, from which children were drawn for Experiment 3, and of teachers in other schools the writer has seen, revealed the presence of two broad types of classroom activity with 'educational materials'. In one type, a group of children are clustered around an object of interest while the teacher explains it, describes it, and elicits responses from the children about it. In the second type, an individual child has been given apparatus which presents some kind of problem to him. The teacher has at some time shown him what he must do with it after which, for a short time or until he gets bored, he is left with it, the teacher returning to him for further encouragement or help, or to set a further problem with the same or with a different piece of apparatus. It is this second type of activity in which we are particularly interested here, for it is potentially similar to our use of the Touch Tutor so far; accordingly, it will be valuable to consider the dynamics of this kind of activity more fully.

The problem chosen for the child probably depends on two main factors. One is the teacher's knowledge of her store-cupboard plus her ingenuity. The other is her knowledge of the child's strengths and weaknesses. Clearly, a child could not be given something which was not in the store-cupboard - nor would it be reasonable to give him something from which he would not benefit.

In turn, the contents of the store-cupboard are determined by the cost and suitability of apparatus for the children, the determinants of which relate to the numbers of children who would want to and who would be able to use the device and to its practicality for classroom use, as well as to its 'educational value'.

It is unlikely that detailed analyses in these terms are made of many pieces of educational apparatus - if of any - in more than common-sense terms. But when, as here in the case of the Touch Tutor, a piece of apparatus appears which involves an expensive decision (expense could relate to finance or to the need for re-organization potentially being involved) a case can be made out for such explicit analysis as this. It is intended, therefore, that this analysis of the use of classroom materials be used as the basis for our investigation of the value of the Touch Tutor in everyday classroom use. Clearly, the analysis has been the basis for evaluating the Touch Tutor throughout the present work but this so far has been done in the context of the laboratory; now it is necessary to consider the machine in the classroom and to state explicitly how this may be done. Applying the analysis, then, it is clear that the basic question we are asking is whether the Touch Tutor should be brought by the school authorities and placed in the store-cupboard. In order to answer this our first need is for information about the suitability of the apparatus for the children. This relates to the numbers of children who would want to and would be able to use it, for how long they might use it, and whether they would be able to use it. The second need is for information about the practicality of the machine for classroom use. This relates to whether children would be able to use the machine without disturbing other children doing other activities and vice versa. It relates also to whether teachers typically would be able to use the machine and whether it would require over-frequent maintenance and technical attendance. The third need is for information about the educational value of the device. This relates to what skills or facts the device may be encouraging and to how restricted a range of such things it may be applied. These needs may be stated as the aims of the following study. Preliminary information about them has already been obtained from the experimentation and analysis conducted in the previous chapters; the purpose of this chapter will be to replicate and extend it.

(3) Method

(i) The school and the children

In the course of visits to educational establishments for S.S.N. children it was realized that the small residential home - 'Redcourt' presented an excellent opportunity to study the use of the Touch Tutor in a classroom setting. The home catered for approximately 80 S.S.N. persons between the ages of 5 and 24. Of these 80, 26 attended school activities daily and their ages ranged from 5 to 16 years. In addition, some of the older children occasionally came into the school for 'evening classes'. The school's principal, asked about the possibility of leaving the Touch Tutor in his school over a period of months, was keen on the idea of trying out this new gadget and communicated this enthusiasm to his staff.

(ii) Instructions to the teachers

The four teachers at Redcourt were each given an explanation of the overall purpose of the study. In this they were told that the Touch Tutor was a machine which had been intended for use by the kind of children in their school as a means of self-instruction in a variety of audio-visual topics. Unfortunately, it had not been extensively tested so that in this study the concern was to discover how well or how badly the machine fitted into the everyday classroom routine of the teachers and children when used in this way. They were to use it just as they might use any other piece of classroom equipment intended for individual use by children and were not to go out of their way necessarily to over-use it or to give it a good report.

It was suggested that they might initially like to aim to try every child in the school on the machine but to use it as and when they found it suitable or convenient. Some children, it was explained, would find the machine difficult to use with some hardly responding at all and others making apparently random responses; others would take to it quickly. They should spend a short period of time ("a couple of minutes") showing the children how to use the machine and encouraging him how to use it correctly but should then leave the child alone with the machine for as long as he wished to respond to it. If he ceased to respond they should encourage him to continue but if he still did not respond they should then not press him further. The important features of the matching task was explained, emphasizing the need to get the child to look at and respond to the Top panel before looking at and responding to the lower panels.

Finally, the need to take recordings of the number of correct and incorrect responses made during each session completed by a child was explained, the time he had spent on the machine, and his general reactions to it. This could be simply done by referring to counters and to a stop clock on the machine [(1)] and by filling in prepared data sheets accordingly.

The general principles of operating the machine, loading programmes and rectifying common faults were also explained to the teachers.

(iii) Siting the Touch Tutor in the classroom

The classroom area at 'Redcourt' consisted of a large room divided by a movable floor-to-ceiling partition. When this was closed, as it usually was, two classrooms were formed. Each of these was inhabited by two classes of approximately seven children each plus their teachers. Low partitions of noticeboards and cupboards divided these two classes from each other. It was therefore possible to site the machine in one corner of the classroom area which, potentially, was accessible to each class. The plan of the classrooms and the position of the Touch Tutor are shown in

(1)These were added to the Touch Tutor especially for this study.

Figure 8.1, which is not drawn to scale. Children using the machine could see and be seen by some of the other children in one of the classes, as is suggested by the plan. The Touch Tutor itself was screened by a 'Wendy House' which showed only the screen of the machine to the child. Doors in the 'Wendy House' allowed teachers to make recordings from the counters and to switch the machine on and off. Some kind of screen for the Touch Tutor was not essential, since the machine could be locked; this screen was found convenient to use, however, in practice since it obviated the need for the doors of the machine repeatedly to be locked and unlocked.

(iv) Programme material

Cleary and Packham's "-2" programme of slides was used for all the children during the study. Auditory material consisted of the spoken names of the objects. The "-2" programme was preferred by the teachers to the black and white pictures as being of more value and interest to the children and it was felt that this fact commended its use.

(v) Subjects

In the course of the study the 23 children who had participated in Experiment 3 and three children who had not, used the machine in a classroom setting. At the beginning of the Study 22 of these 23 children had had two sessions with the Touch Tutor in the Mobile Laboratory and one had had one session. In the two months of the Study most children had one session with the machine but five children had two and one had three sessions. As in the previous Studies, no precise overall data concerning the M.A.'s or I.Q.'s of the sample was available. Chronological Ages of the children have been given in relation to Experiment 3.

(vi) The Experimenter's role

In the course of the study four visits were made to 'Redcourt'. The first involved discussion with the teachers during which the aims of the study were explained, the machine demonstrated and the essentials of the matching to sample task explained. The second, one week later, involved general discussion with the teachers about their reactions to the machine during the week, and the clarification of any points of difficulty about the machine or the project. The third visit (three weeks later) involved photography of 'Redcourt' and of the machine, during which the teachers were encouraged to continue working with the machine so that

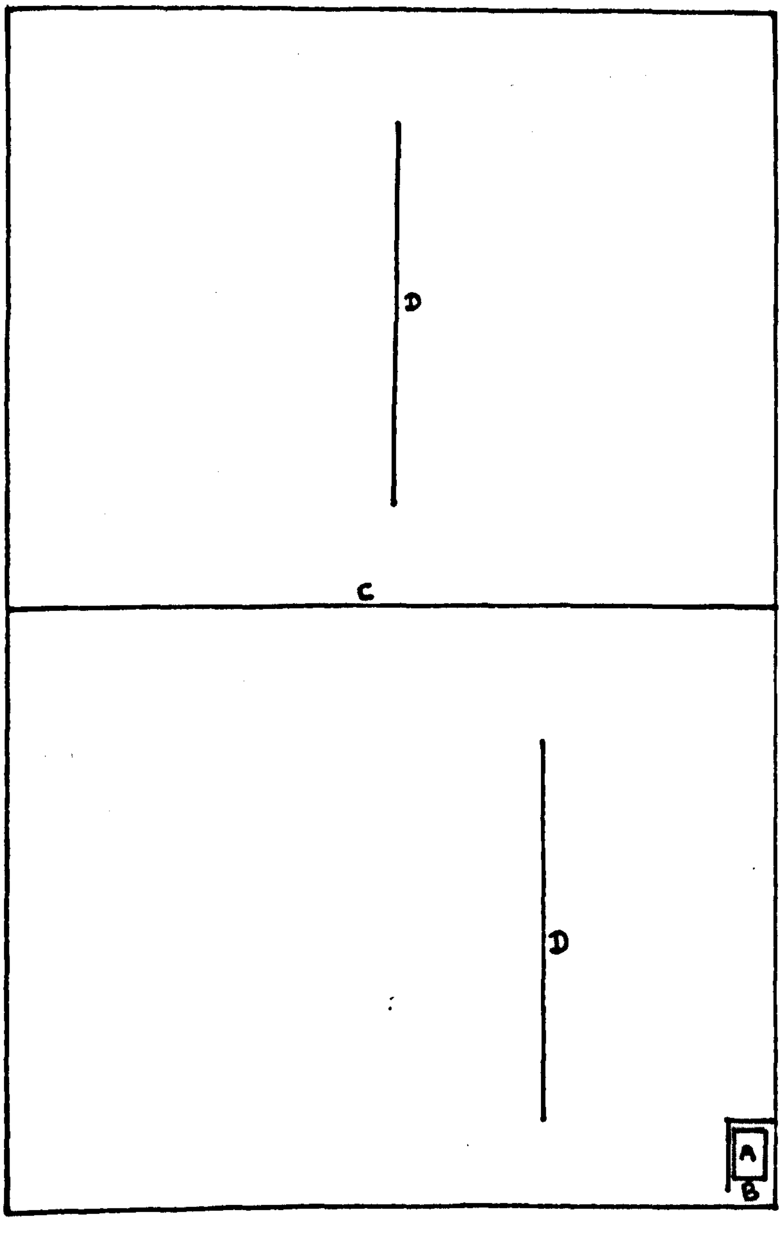


Figure 8.1

Plan of the classroom area at 'Redcourt' (not drawn to scale). The Touch Tutor can be seen at 'A', located in the 'Wendy House' ('B'). The classroom area is divided by a floor-to-ceiling partition ('C') and low room-dividers ('D').

general observation of their approach to the children in relation to the Touch Tutor could be made. The fourth visit, at the end of the Study, consisted of further discussion with the teachers but also individual observation by E. of all children working on the machine. The main purpose of such observation was to check the accuracy of the two recording counters on the Touch Tutor which recorded the number of correct and incorrect responses made by children, which the teachers had suspected were faulty, as well as to gain a deeper understanding of the ways in which the children were responding to the machine. In discussing the Results of the Study this last period of observation will be referred to as the 'Post-test'. For this a series of 10 'one-choice' and 10 'three-choice' slides were selected as a fairly representative sample of the '-2' programme and followed by 10 one-choice and 10 three-choice slides from the black and white series of slides used in previous experiments. Children were allowed to work on these slides with a prompt but no instructions from E. at the start of the 'Post-test' period. Children who failed to reach criterion on the sections of this test were allowed to repeat the section; it happened, however, that no child managed to better his score significantly on repeating the test. Therefore, the results of the first presentations of the slides only will be presented.

(4) <u>Results</u>

In presenting the Results of this study of the children working upon the Touch Tutor in a classroom setting, data will be discussed under two broad headings. The first will concern the responses of the children to the Touch Tutor; the second will concern the teachers' responses to its presence.

(i) <u>The children and the Touch Tutor</u>

(a) <u>The Touch Tutor's 'attractiveness'</u>

During the period in which the Touch Tutor was in the classroom of Redcourt 23 of the 26 children in the sample completed at least 8 slides unaided, according to the teachers' records. Considering that only the 22 children who took part at the end of Expriment 3 and in the present Experiment, these figures represent an improvement in performance for 7 children and a deterioration in performance for one child.

In the 'Post-test' stage of the present Experiment the above apparent improvement was noted in 3 of the 7 children; 2 of the children were, however, absent. The one child who had shown a drop in performance once again reached criterion. In the Post-test, therefore, 20 out of 24 children were observed to reach this criterion of responding.

Thus, although the period children spent with the Touch Tutor in their classrooms seems to have been effective in inducing some children to respond to it, such performance was not maintained in all these children in the 'Post-test'. The reasons for this were not apparent, except in the case of one child who had been so timid of the Touch Tutor (and yet interested in it) that the teacher had had to sit with her and help her to respond.

Data for the 23 children who completed at least 8 slides unaided while it was in their classroom are portrayed graphically in Figures 8.2, 8.3 and 8.4. The graphs show, respectively, the time children spent with the machine, the numbers of slides they completed and the ratios of these two measures ('response rate'). The data, again taken from the teachers' records, may be seen in full in Appendix 4 (as may all the data of this Experiment).

Figure 8.2 shows that the time children spent at the Touch Tutor ranged from below 5 to about 55 minutes. The mean time was 18.74 minutes (S.D. 12.17 minutes), which is artificially raised by the extreme times. More representative of central tendency is the median of the data, which was 15 minutes (semi-interquartile range 10.21 minutes).

Figure 8.3 shows that the number of slides children completed ranged from below 40 to above 200 slides. The mean of these data was 82.96 (S.D. 53.94), and the median was 79.34 (semi-interquartile range 40.36).

Figure 8.4 reveals that the response rate of children ranged from below 1 response per minute to above 7 responses per minute. These data were more normally distributed than those of Figures 8.2 and 8.3, the mean being 4.62 slides per minute (S.D. 1.66) and the median 4.8 slides per minute (semi-interquartile range 1.46).

The measure of response rate permits comparison of the responding of these children with the responding of children in the earlier Experiments. The mean rate of the present Experiment is not significantly different from that of Experiment 1 ('t' = 1.0284, d.f. = 58) and it is similar to the overall rate for 15 children (5.01) during Experiment 3. (With regard to the latter comparison it should be noted that evaluation of the extent of difference between the rate for each Experiment is not legitimate, unless the rates of the same subjects were used. This could, however, give a misleading result.)

Figure 8.2

Distribution of times spent working at the Touch Tutor by children during Experiment 4.

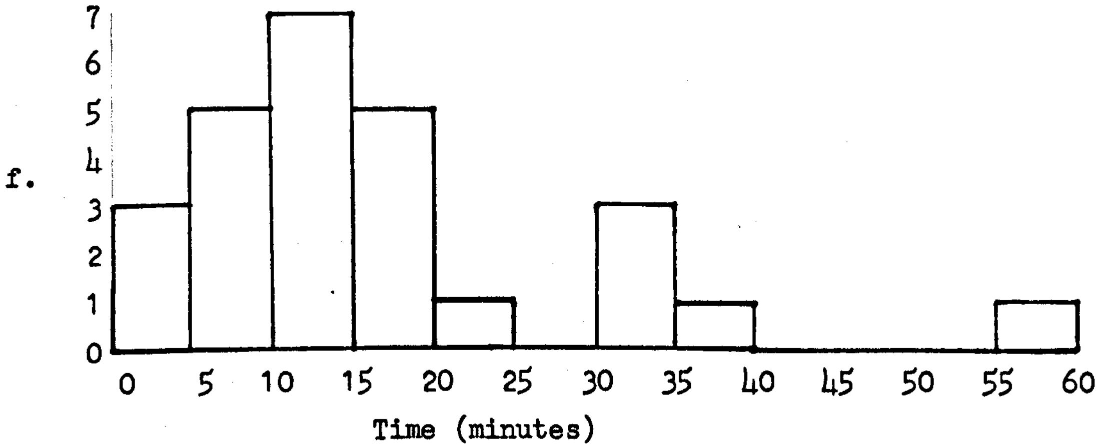


Figure 8.3

Distribution of slides completed at the Touch Tutor by children during Experiment 4.

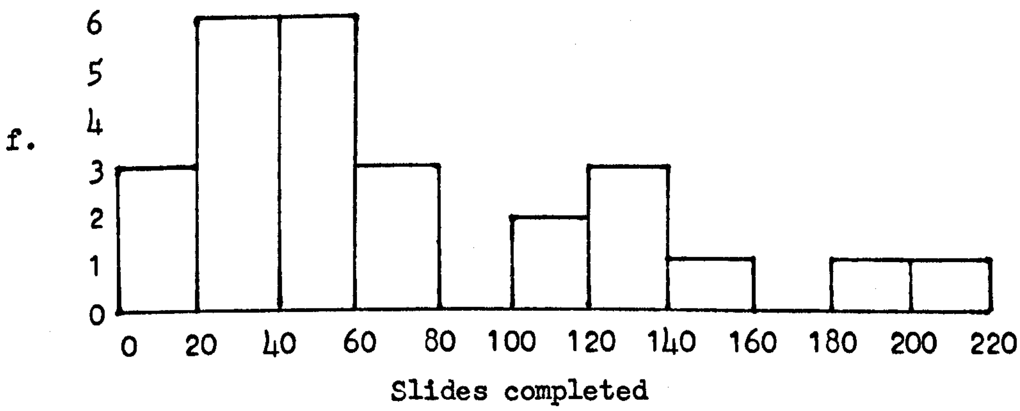
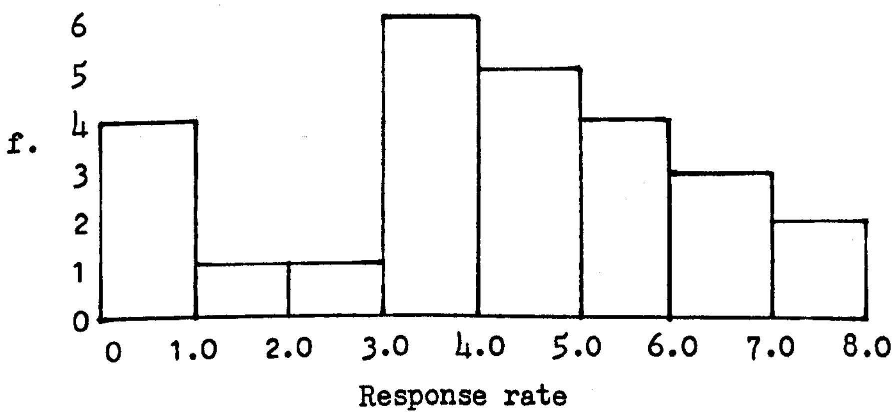


Figure 8.4

Distribution of response rates of children working at the Touch Tutor during Experiment 4.



Data on the above three variables was not obtained during the 'Post-test'. E. had the impression, however, that children were responding at a similar rate to that which had been recorded for them during the 'classroom' stage of the Experiment. Some marked exceptions occurred, which were discussed above.

These date suggest that the sample as a whole found the Touch Tutor attractive, inasmuch as 23 of the 26 children studied spent a median time of 15 minutes working on the machine, apparently on their own, during which they completed a median of approximately 79 slides, at a mean rate of 4.8 slides per minute. General agreement was found between the recorded behaviour of children during the 'classroom' stage of the Experiment and that observed by E. during the 'Post-test' stage, although some discrepancies occurred. Comparisons with other Experiments showed that some children had begun to respond to the Touch Tutor since the end of Experiment 3 and that the mean response rate of the present Experiment was not significantly different from that of Experiment 1. The mean response rate also seemed similar to that of 15 children in Experiment 3 but statistical comparisons could not be made.

(b) <u>The extent of correct performance</u>

During the 'classroom' stage of the Experiment, 8 children (31% of the sample of 26) attained a score higher than the criterion level of 90% slides correct adopted by the makers of the Touch Tutor for their "-2" programme of slides. Two of these children had reached criterion during the last 10 slides of Experiment 3, the criterion level for that Experiment being 8 out of 10 slides two-choice slides correct; one other child was absent during Session 2 of that Experiment.

During the 'Post-test' stage, 6 of these children scored at least 8 out of 10 (in fact, all children scored higher than this) three-choice slides correct, signifying that they had maintained their matching to sample performance. In addition, 3 children reached the minimum criterion of 8 out of 10 slides correct who had not done so during the 'classroom' stage. Two of the 9 children had reached criterion at the end of Experiment 3.

Once more, therefore, differences occurred between the numbers of children apparently able to match to sample at the end of Experiment 3, during the 'classroom' stage of the present Experiment and during the 'Post-test' of the present Experiment. The discrepancy between the number of children matching to sample at the end of Experiment 3

(2 children) and those doing so both in the 'classroom' and in the 'Post-test' stages of the present Experiment (6 children) could be due to genuine improvement in matching by those children. The discrepancy between the 'classroom' and 'Post-test' stages of the present Experiment is harder to explain. The three children who reached criterion in the 'Post-test' who had not done so in the 'classroom' stage could have but recently learned to match to sample, in which case their overall score would have been determined largely by the essentially random scoring of their pre-solution periods. This is a reasonable explanation for their improvement and, in view of a comment about one child by his teacher that he had eventually realized what he had to do to make the machine speak, seems at least likely. If it is the correct explanation, there is in fact no discrepancy between the 'classroom' and 'Post-test' stages. The teachers could throw no light on the discrepancy affecting the two remaining children. This was such a large discrepancy, with the two children appearing to jump from no responding in Experiment 3, to nearly 100% correct performance during the 'classroom' stage, back to no responding in one child and no correct responding in the other, that some kind of recording error would seem to be the cause.

Measurements of the correctness of responding to one-choice slides was not possible during the 'classroom' stage of the Experiment. All the children who completed at least 8 slides scored between 31% and 84% slides correct but this would not necessarily distinguish between completely incorrect performance and correct responding to one-choice slides. Considering only the extent of one-choice responding during the 'Post-test', therefore, 19 children in the sample scored a minimum of 8 out of 10 one-choice slides correct. Of the children who took part both in Session 2 of Experiment 3 and in the present 'Post-test' (n. = 20) this represents a rise in performance for two children and no drop in performance. This could be due to genuine improvement.

Summarizing this section of the Results, improvement in the performance of children since the second session of Experiment 3 was noted, particularly with respect to matching to sample. Discrepancies between the recorded performance of children during the 'classroom' and 'Post-test' stages of the Experiment existed but they seemed, except in the case of two children, to be due to genuine improvement. Thus, in the 'Post-test' of the Experiment, 9 children were observed to be matching to sample on three-choice slides and a further 10 children were observed to be responding correctly to one-choice slides only. Expressing these as percentages of the total sample (24, since two children had gone home) 38% of the sample were matching correctly and 42% resonding correctly to one-choice slides only.

(c) General observations

The general impression of the responding of children in terms other than of the correctness and enthusiasm of their responding suggested that it was essentially similar to that of children in the previous Experiments. During the 'Post-test', for example, children responded with the typical variants of Top responding, they engaged in Subsequent responding and they adopted familiar patterns of response to the lower panels of the machine.

One interesting feature was that these responses were confined mainly to children who were not responding correctly to the matching slides. Children who were matching the majority of three-choice slides correctly systematically responded with Top and Bottom responses in that order and with no Subsequent responses. A somewhat similar trend for matching to sample and the type of responding demonstrated by E. to be positively correlated may also be discerned in the data of Experiment 2.

It will be noted that no mention has been made of the performance of children in the two halves of the 'Post-test', which involved testing children with the black-and-white, line-drawn slides as well as with the coloured slides of the "-2" series. In fact, the performance of all children on the two series of slides was, in terms of criterion performance, identical. Neither were any other differences apparent.

Finally, the use of the coloured slides of the "-2" series does not seem to have markedly affected the responses of children to the Touch Tutor, in comparison with the balck-and-white, line-drawn slides. It is possible that the introduction of these to these children could have helped some children to develop correct matching to sample performance, just as the introduction of the 'nonsense shapes' at the end of Experiment 1 suddenly caused two children to jump to correct matching after a period of random responding, but there is no evidence that this occurred.

(ii) The teachers and the Touch Tutor

The teachers were asked about their reactions to the Touch

Tutor during their use of it at Redcourt. The teachers in general were favourable in their comments about the machine but not expecially enthusiastic. With regard to its use in the classroom, there had been no especial problems raised by its presente. In order to carry out the aims of the study teachers had themselves decided to change classrooms in rotation, so that each class would be in the section of the whole classroom which housed the Touch Tutor. This had appeared to work without major problems. After the first day or so of its use by each class, children had ceased crowding around it while it was being used by one of them and had reverted to their 'typical' classroom behaviour. One or two children had been a little frightened of it and the teacher had had to sit with such children for a little longer than had been necessary for other children. With regard to its potential usefulness, the teachers were reserved. Although it had seemed likely to be particularly beneficial to one or two children - in encouraging concentration - and had led two children to reveal a potential which had never been recognized previously by anyone in the school - (one child had spoken for the first time when confronted with the machine; another had shown an interest in the machine which he had never shown in any other classroom task) - it was thought to be, in its present state, of no particular value for other children. Perhaps, they thought, since most of the children did enjoy using it and quite a few were able to match to sample on it already, it could be of some use if a wider range of teaching material were available for it. Asked about what sort of teaching material they could envisage, however, they were unable to say what they thought the machine could profitably teach. Of the four teachers, one was a little more forthcoming and believed that she would be able to generate some ideas if she were given time to think about it. These discussions with the teacher and the 'psychologist' ended with the problem being thrown back to the latter - what could <u>he</u> see the Touch Tutor profitably teaching?

It was the writer's impression that three of the four teachers were tolerant, but little more, of the Touch Tutor: possibly they would not have used the machine had not E. re-visited the school at intervals. This impression is based on the fact that teachers seemed only to be using the machine on days after E. had telephoned the Principal to say that he would be paying a visit on a particular day; inspection of the dates upon which children were tried on the Touch Tutor by the teachers showed that these tended to be in the two or so days after E. had telephoned and before he made the visit, even though a week or more might have elapsed since his last visit. The one enthusiastic teacher was different, however. Not only had the children in her class not been tried on the Touhh Tutor coincidentally with E.'s visit but she had allowed a group of older children, who attended a sort of 'night school' each evening, to work on the machine. Her comments suggested that she considered the machine of more value to these older children than to the younger ones.

(5) Discussion

Much of the argument presented in this Chapter rests on the data recorded by the teachers during their use of the machine in the classroom. It could be argued that these data are false due to the desire of the teachers to please the experimenter, or whatever, or due to the unreliability of the recording devices. Alternatively, the data, although intrinsically accurate, could have been gained in circumstances different than the Experimenter had intended.

With regard to the former criticism, we have devoted space to discussing discrepancies between measurements recorded by the teachers and those observed by E. during the 'Post-test'. These have shown general agreement between measurements obtained on the two occasions both with regard to the enthusiasm of children's responding and to its correctness. Inexplicable discrepancies occurred but these affected few children, and some discrepancies were probably to be expected in view of the results of our previous experiments.

With regard to the latter criticism, as far as E. could ascertain teachers did, for the most part, use the machine as E. had suggested to the teachers - that is, they had not gone out of their way necessarily to use the machine (as noted above, there was a possibility of this having occurred, however) or to give it a good report and they had shown children how to use the machine, then leaving the child alone until he had become tired of it. There was certainly one exception to this when a teacher sat with one excessively timid child; it is impossible to know how far it occurred to a lesser extent with other children but presumably, in view of the agreement of 'classroom' and 'Post-test' stages, if teachers did sit with children they did not take the major part in responding to it. Unfortunately, there is no way in which this problem can be satisfactorily answered - and upon it hinges whether the present Experiment can be regarded as a study of the extent to which the Touch Tutor might be used by children working alone in a classroom setting, or whether it may merely be considered another study of 'Experimenter and Child' being present at the machine together. One fact which may be taken as evidence that teachers did not sit with children continually is the presence of other children in the classroom who would have needed some attention from the teacher. This, coupled with the writer's observations on his visits, may suggest that teachers typically did not sit with the children continually; the issue must not be regarded as resolved, however, because of these two pieces of evidence alone.

If one regards the study merely as essentially similar to the Experiments reported earlier in this work the data may be regarded as confirming the general findings of those studies. We have once again seen the general division of children into those responding and not responding to the machine, into those matching to sample correctly, into those responding only to one-choice slides correctly and into those responding to no slides correctly; once again, the typical response patterns have again appeared. The overall response rate of the sample was similar to that of children in Experiment 1. Moreover, the increase in the numbers of children matching to sample during the Experiment, in comparison with the numbers doing so at the end of Experiment 3, resembled that which occurred in the Stallington children during the period after the end of Experiment 1 until the end of Experiment 2. Thus, in both samples of children, instances of fairly rapid acquisition of matching to sample occurred (which, in some cases, had the character of being due to reminiscence - in that it appeared after an interval of no practice on the Touch Tutor) together with instances of more gradual improvement. Finally, fluctuations in criterion performance have occurred in the present Experiment. Similar fluctuations have occurred in each previous Experiment, and they are probably due to a combination of factors. Possible factors are day-to-day variation in the children, specific reaction of children to different experimental circumstances, minor variations in performance around the criterion level and, of course, genuine improvement in performance.

If one chooses to regard the Experiment, on the other hand, as indicative of the possible individual use of the Touch Tutor by children in the classroom, the Experiment has shown that this is possible. The majority of children in the school used the Touch Tutor for at least a short period of time; the group of children as a whole responded to it for a median period of 15 minutes completing a median of 79 slides during that time. Moreover, the presence of the machine did not seem

Moreover, the presence of the machine did not seem to interfere markedly with the normal classroom activities, the children working with a minimum of supervision while teachers continued with teaching other children in the class.

The Experiment seems to have thrown some light upon the reactions of teachers to the presence of a machine like the Touch Tutor in their classrooms. One must, of course, remember that this could be a most unrepresentative picture of the attitudes of teachers to the presence of a machine like this. On the other hand, if it is representative, it is clear that the introduction of machines like the Touch Tutor into the school classroom would have to be accompanied by an initially strong source of encouragement and persuasion to use the machine, together with an extensive selection of programme material. For, on the evidence of this Experiment, the majority of teachers would not be particularly inclined to use the machine, nor would they have many ideas for the development of further programme material.

The implications of these considerations are, perhaps, that introduction of the Touch Tutor would be most efficient if an interested person were given the task of arranging the use of the machine by children in a school. She would sit with children, if need be, while they used the machine and she would be responsible for developing further programme material for it, in conjunction with the teachers. This would clearly obviate the need to debate upon whether children could use the machine in the classroom without the continual presence of a teacher, and would overcome the problem that some teachers might not wish to use the machine if it were left in the classroom, nor to develop further programme materials.

One final problem the presence of the Touch Tutor, in a school setting raises is that of technical maintenance and repair. The Touch Tutor used by the author had three major faults. Firstly, it would, on occasions, not detect touch responses - sometimes because the child's finger was too dry. The consequence of this was that some children would cease to respond while others would impatiently tap the panels. Secondly, the machine would sometimes detect a response but would not subsequently speak, or change slide or react to further responses unless a 'reset' button was pressed. Thirdly, it would sometimes go out of synchronization, so that the spoken stimulus word would be inappropriate to the visual stimulus displayed on the machine. As far as the writer could tell, the first and last of these faults were common to all Touch Tutors, the second one idiosyncratic, being apparently a consequence of fitting the two recording counters. These faults were intermittent, sometimes occurring once in 10 slides, sometimes once in 40 slides, but with little predictability (if anything, the weather seemed to affect their frequency!) During Experiments 2, 2a and 3 these faults were avoided by the use of hand-held buttons by E. and the careful checking of the synchronizing controls before children used the machine. Before Experiment 4, the machine was examined and the sensitivity of the Touch panels increased by cleaning, and repair of a broken connecting wire. In addition the synchronizing controls were checked. These precautions lessened the faults but did not eradicate them, so that teachers were instructed in the synchronization technique and given the hand-held buttons with which to reset the machine if it 'stuck' without opening up the 'Wendy House' around the machine. The teachers were asked about these faults during E's visits and it appeared that they still occurred.

The implications of these faults are two-fold. Firstly, it is possible that the numbers of slides children completed and the response rates are lower than they could have been. Secondly, the continued intervention of someone with some mechanical knowledge of the Touch Tutor would seem to be necessary for its operation to be maintained.

(6) <u>Conclusions</u>

Experiment 4 has enabled some of the problems of introducing a machine like the Touch Tutor into the everyday teaching situation to be examined. It would seem that the machine could be used by teachers with fairly little disruption of their normal classroom life and that children would respond to the machine well. Doubts were raised, however, whether children would <u>necessarily</u> sit working on the machine unaccompanied, whether some teachers <u>necessarily</u> would use it at all frequently and whether ideas for the development of further programme material would be generated by teachers. Accordingly, it seemed that the introduction of a machine like the Touch Tutor might have to be accompanied by someone prepared to oversee its initial use; possibly the best arrangement of this would be the appointment of one person to be permanently responsible for supervising children in its use and generating programme materials for it.

This Experiment is the last examination in this work of the responses of children to the basic programme material of the Touch Tutor. A fairly consistent picture of the responses of S.S.N. children to the machine in its basic form seems to have been gained and the need now would appear to be the development of further programme materials for it. Such development raises not only technical problems but problems of knowing what the machine may be used to teach S.S.N. children. The next chapter is aimed at elucidating these two problems and, in particular, the latter.

CHAPTER 9: DEVELOPMENT OF PROGRAMME MATERIAL FOR THE TOUCH TUTOR

(1) Introduction

Some attention has been paid in previous chapters to the extent to which children are able to match to sample on machines like the Touch Tutor. Once they demonstrate a grasp of the principle and begin to reach criterion performance on slides of easily discriminable material, however, other educational goals are possible and attention must then be focussed upon programme material rather than upon the basic skills required to operate the machine. At the time of writing little programme material was, however, available for the Touch Tutor; moreover, few discussions seemed to exist about the kinds of subject matter the machine could profitably teach. Accordingly, it seemed valuable to devote space to a consideration of relevant approaches to the development of further programme material and to some of the problems such development might raise. That is the aim of the present chapter. We shall consider in the chapter some possible approaches to the development of further teaching material for such children, examining first the origins of the matching to sample technique.

(2) Matching to sample and discrimination learning research

As we shall see below, Skinner's aim for the machine he designed for pre-school children (see chapter 2) was that it should be used to teach discriminations which, he claimed, it could do better than could a human teacher. This was, in fact, an unusual emphasis to place upon the task of matching to sample for since Weinstein's (1941) work it had been used primarily as a means of testing discriminations for which it was a technique superior to the more traditional methods of two-choice discrimination learning and learning-set formation, in that it enabled more discriminations per trial to be tested.

Yet despite this apparent superiority as a means of testing discriminative ability the matching to sample technique has been infrequently used in either animal or child research in comparison to the frequent use especially of the two-choice discrimination learning set-up (see, for example, Gibson and Olum, 1960). The reason for this would seem to be the difficulty the task itself presents to both animals and children. The study of Weinstein (1941), which studied the performance of monkeys and young children, and of Lashley (1929), which studied the performance of rats, in matching to sample tasks provided early illustrations of the difficulty such subjects may have in learning the essentials of the task. That is, they might not have difficulty with the discrimination of the stimuli used but rather with the skills the task requires. The realisation that the task itself might be difficult came to Weinstein and it has come to workers since, many of whom have attempted detailed analyses of the skills required by the task in order that the subject's mastery of it may be speeded up (for example, Ferster, 1960; Nevin et al., 1963; Fellows, 1965). Even so, there does not seem to have been markedly greater use of the technique in research into discriminative processes. Instead, the technique has become popular as an educational technique which, in view of its background, might seem to be something for which it was not entirely suited, being more suitable as a means of testing discriminations.

(3) Matching to sample as an educational technique

The use of matching as a means of instruction can be seen as arising from a desire to find an educationally valuable way of designing teaching machines for subjects unable to read. For such a purpose the task was entirely suitable, especially for machines designed by Skinnerian workers, since each frame of a teaching programme in matching format would offer the subject a problem, require an overt response and enable the machine to provide appropriate reinforcement. The problems presented on each frame could, moreover, be made progressively difficult in order to lead the subject to attain the desired level of competence by small steps.

No other known format could provide these advantages; presenting a single stimulus would provide no comparable problem for the child; presenting stimuli in the classical two-choice discrimination learning format would require a series of slides to be presented for each problem, instead of one; delayed discrimination or delayed matching formats would have no obvious advantages, neither would asking the subject to press buttons according to whether stimuli were the same or different (Filby and Edwards, 1963, tried this before subsequently adopting matching to sample).

However, deciding upon a suitable means of presenting stimulus material is not enough; there still remains the need both to decide what a format can be used to teach and to decide just how material should be sequenced. Historically, there are two main approaches to these issues which are directly relevant here, the Skinnerian on the one hand and that of Cleary and Packham, the originators of the Touch Tutor, on the other.

(i) Skinnerian use of the matching to sample format

Skinner's aim for the matching to sample technique in conjunction with the advantages of a teaching machine as he saw them was that it could be used for the teaching of discriminations:

> "The ability to make a given kind of discrimination can be taught. A pigeon, for example, can be made sensitive to the colour, shape and size of objects... simply by reinforcing it when it responds in some arbitrary way to one set of stimuli and extinguishing responses to all others. The same kinds of contingencies of reinforcement are responsible for human discriminative behavior." (1961a; quotation taken from Skinner, 1961c, p.182, Skinner's emphasis.)

Skinner made it clear in this discussion that he regarded 'discriminating' as an important, basic skill; one which, above all, could be taught (see also Chapter 2, this volume).

Holland (1962) expanded this argument. He criticized emphasis placed upon the teaching of facts in programmes, preferring rather that fundamental skills should be taught - i.e. the 'hows' not the 'whats' of learning. Discrimination learning was an example ofthis more valuable approach, he said, and described four pieces of work as examples of it. These were: Evans' (unpublished) work on discrimination training in young children; Holland and Matthews (1963) work on the training of auditory discriminations to normal children with defective speech; Skinner's own (unpublished) work on a programme to teach form discriminations on a matching to sample machine; and Long's (unpublished) work on the training of inductive reasoning in children. Let us briefly examine these in turn.

Evans showed that requiring children to discriminate letter patterns vastly improved their ability to draw them; no other details of this study are given by Holland, and none could be found by the present author.

Holland and Matthews (1963) modified a tape recorder so that 8 and 9 year old children requiring articulation therapy would be reinforced after discriminating difficult sounds correctly. Children with defective 's' discrimination and articulation improved both of these after working through the 585 items of the teaching programme on the tape recorder even when no work had actually been directed at their articulation. The results suggested to the authors that:

> "Challenging opportunities lie in the extension of teaching machine concepts to other areas of speech pathology and audiology." (p.482)

Skinner's programme (described briefly in Holland, 1960) with which no work seems to have been done, was used as an example by Holland as he pointed out that, although simple form discrimination was an essential skill, the skill of being able to abstract properties from forms (concept formation) was perhaps more important still in education:

> "However, little academic education is simple discrimination. More often, it is abstraction, or concept formation. An abstraction is a response to a single isolated property of a stimulus... There are red balls, red cars, red walls. The term red applies to them all, but not to green balls, blue cars, or yellow walls. To establish an abstraction... we must provide many examples. Each must have the common property, but among the various examples there must be a wide range of other properties. This is best illustrated by examples from the preverbal machine shown below." (Holland, 1960, p.282)

The examples given by Holland are illustrated in Figure 9.1.

Holland's final example of the kind of approach he was advocating was the work of Long. A 234-item matching to sample programme (of which some items are shown in Figure 9.2) required mildly retarded and normal children aged 6 - 9 years to reason inductively to gain reinforcement. The child's task was to select the stimulus which correctly completed the series shown in the upper panel. The programme was tried and revised by Long but no extensive validation of it appears to have been carried out.

These studies are important as illustrations of an educational 'philosophy' suited to programme development with matching to sample machines and two of them offer some evidence of its value in apparently demonstrating the transfer of skills acquired during training to other tasks. Unfortunately the fact that these studies are available in but scant detail must lead to caution about accepting the value of this approach to programme development too readily.

In some respects the studies described in Chapters 2 and 3 of this volume adopt a similar belief in the value of discrimination training. The general approach of these studies, it will be recalled, was to teach the particular mode of operation of a particular teaching machine (which usually involved matching to sample) to the subjects, to

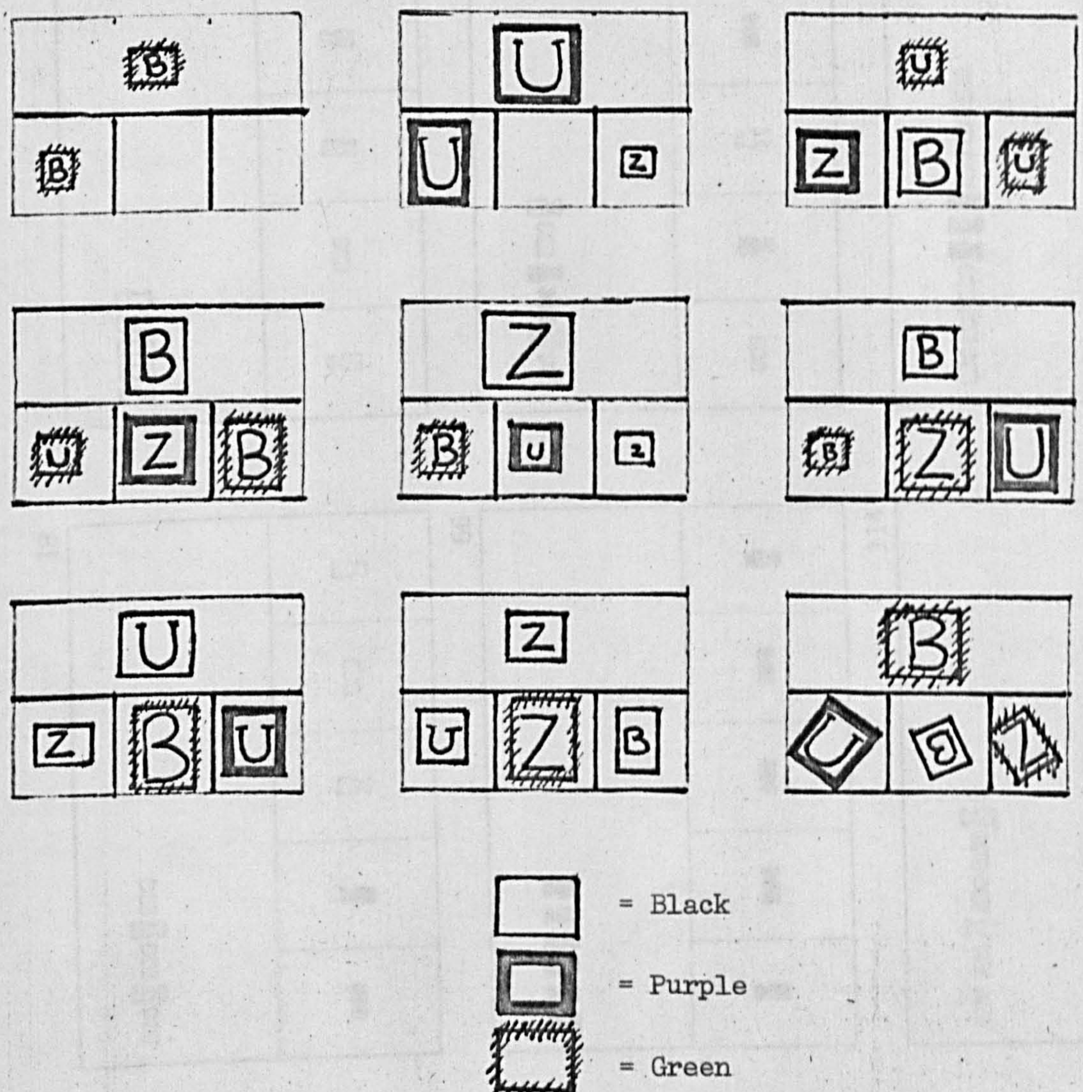


Figure 9.1

Selected items from a programme described by Holland (1960) which aimed to teach children to respond in terms of the abstract property of form. The child's task was to match the same letters on each slide. Colour begins as a relevant cue but becomes irrelevant in later items, as do the stimulus properties of size and orientation.

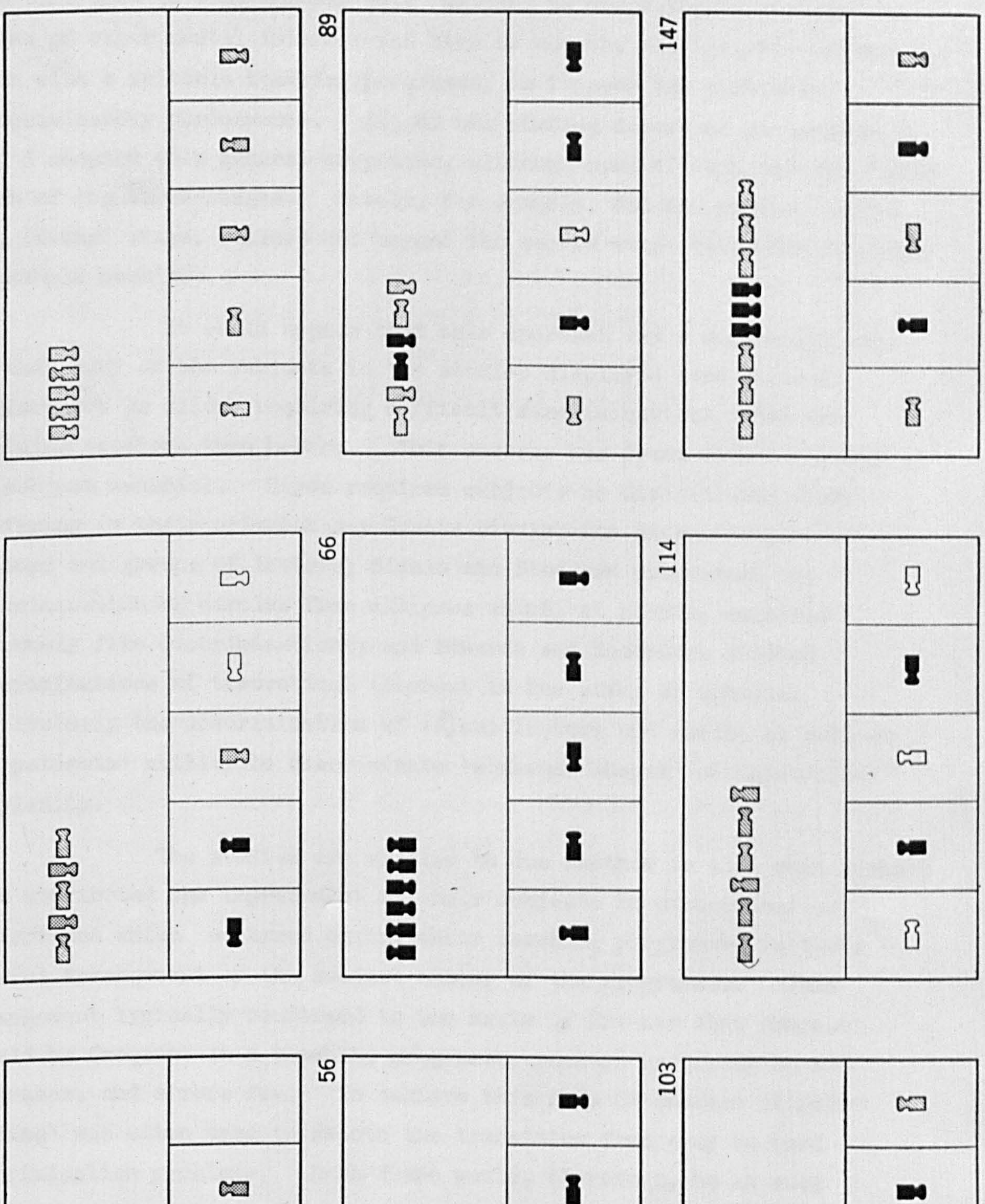


Figure 9.2: Slides used in the study of Long in the teaching of 'inductive reasoning'. The child's task is to select the stimulus in one of the lower panels which continues the series of stimuli shown in the upper panel.

use this then to test the subjects' ability to discriminate various forms of experimental interest and then to use the machine, in conjunction with a suitable teaching programme, to improve the particular discriminatory performance. All of the studies described in Chapters 2 and 3 adopted this general aapproach, although some of them did not repeat each of its three stages. Hively, for example, did not proceed beyond the initial stage, Fellows not beyond the second stage (with his matching to sample machine).

It would appear that this approach was a successful one, in that many of the subjects in the studies displayed more correct performance on slides requiring difficult discriminations after the training sessions than before. This success was found with a variety of subject material. Bijou required subjects to discriminate forms differing in their orientation; Staats studied the discrimination of letters and groups of letters; Sidman and Stoddard programmed the discrimination of circles from ellipses which, at points, required extremely fine discriminations; and Edwards and Rosenberg studied discriminations of theoretical interest in the study of aphasia, particularly the discrimination of various letters and words, as well as the patients' ability to discriminate 'nonsense shapes' of increasing complexity.

The studies are similar to one another in that such authors each attributed the improvement of their subjects in discrimination performance which occurred during their teaching programmes to their careful arrangement of the subject matter of the programmes. This arrangement typically conformed to the maxim of Skinner that success should be frequent in a teaching programme, perhaps occurring on 90% of frames, and errors few. To achieve this rate of success stimulus 'fading' was often used to smooth the transition from easy to hard discrimination problems. Each frame would, therefore, be an easy problem for the subject and he would receive frequent reinforcement during his performance on the programme. The doctrine that learning is the responsibility of the teacher to teach effectively rather than that of the pupil to work at the solution to problems himself is readily apparent in this approach to programme development, it may be noted.

Despite this careful design of programmes, however, there have been occurrences of children developing patterns of incorrect responding in each of the studies cited. This emphasizes, of course, the fact that careful programme design must necessarily involve a specification of a 'target population' of the subjects for whom the programme is designed. Using programmes outside their 'target population' necessarily must reduce the value of careful design.

Such studies demonstrate that the use of teaching machines employing the principle of matching to sample, in conjunction with carefully designed programmes employing the principle of stimulus fading, can be used to improve the discrimination performance of some subjects on a selection of visual material. They thus illustrate the overall feasibility of the proposals of Skinner and Holland that such methods may be used for the teaching of discriminative skill. However, they show merely that performance on the immediate teaching programme may improve; they do not show that such skill may transfer to other tasks.

The proposals of Skinner and Holland and the work described above represent one important approach to the development of programme materials for matching to sample machines such as the Touch Tutor. We have seen that this approach emphasizes the teaching of visual discrimination performance, by programmes involving a gradual increase in difficulty, with the immediate aim of improving discrimination performance on particular classes of stimuli or of teaching a general skill of discrimination which would be useful in other aspects of education for the subject. Similarly, it has been suggested that other basic educational skills, such as inductive reasoning, might be taught in the same way. The studies cited have shown the possibility of improving discrimination performance on particular classes of visual material but have provided little evidence of the possibility of the transfer of skill from machine and programme to other tasks.

We shall now turn out attention to the programming style of Cleary and Packham, the originators of the Touch Tutor, which represents a second important approach to the development of programme materials for the Touch Tutor.

(ii) The use of matching to sample by the originators of the Touch Tutor

Cleary and Packham do not seem to have offered any rationale for the way in which their programme material is designed, but it clearly represents a different approach to that taken by the various workers described above. In their programme the child is given no help from a gradual progression of subject matter (or indeed from anything; although it is noteworthy that they did devise (see Cleary et al, 1970) a version of the Touch Tutor in which a device dimmed the incorrect response alternatives when a child's performance fell below a certain level. The technique was never developed, however, beyond its initial stages, but is offered a randomly arranged assortment of matching problems. The child is intended to work at these until his performance improves through a process of trial and error, the programme material endlessly recirculating. With regard to subject matter, some of the slides contain material similar to that used by previous workers - the child is asked to match pictures, colours or geometric shapes, which are easily discriminable stimuli, or words or phrases, requiring more difficult discriminations - but on other slides they introduce the more difficult task of matching 'conceptually' as opposed to the 'perceptual' matching of the visual discrimination items. In these slides the sample item is a word or phrase and the response items are pictures, one of which is a picture of the object or action indicated by the sample word. If the child cannot read his initial response to such slides has to be a guess since, unlike the 'perceptual' matching slides, the correct choice is not indicated by the stimulus array alone. If the child makes a correct choice the machine names the stimulus word which both rewards the choice and 'ties together' the word and the picture. Apparently this naming is much more effective in improving performance on these 'reading' slides than is a more general reinforcement such as 'Well done' (Huskisson et al., 1969). It would appear, therefore, that the introduction of the machine naming the sample stimulus presented by the machine is a valuable addition to the matching to sample technique in that it seems to increase the effectiveness of 'conceptual' matching slides. It has the additional advantage, of course, in that it enables the machine to be used for the presentation of much more 'factual' information. The machine could be used to present the child with the names and attributes of objects unknown to him.

In 1971 thirteen programmes were available from the makers of the Touch Tutor of which seven, designed with S.S.N. children in mind, involved the matching of colours, shapes and pictures, and six with the matching of words to their picture equivalents. Unfortunately, little information is available concerning the progress of children on these programmes so that it is difficult to evaluate the effectiveness of Cleary and Packham's programming style. It would appear from the data that is available that some S.S.N. and young normal children responded well to the programmes and that they could progress through them until they were matching the majority of slides correctly. On the other hand some children developed incorrect patterns of response such that their performance remained at chance level throughout their work on the programmes. No reports of transfer of knowledge or skill obtained on the machine to non-machine situations seem to exist.

These results are similar to those obtained with the programming styles of Skinner and his followers. We may now legitimately ask whether any differences in the effectiveness of the two styles in achieving these results is apparent.

(iii) Differences between the two programming styles

The approaches to programme design of Skinner and his followers, and of Cleary and Packham, are different in two main respects. The first relates to the advantages or disadvantages of a careful sequencing of material as opposed to its random distribution throughout the programme. The second concerns the educational value of specific aspects of the methods; whether, for example, the teaching of discriminations is a valuable thing to do and what advantages, for example, verbal naming might have. These two points may be seen as concerning how best material may be taught by such matching to sample machines as the Touch Tutor and what kinds of material may fruitfully be taught.

(a) The arrangement of programme items

A number of studies (Terrace, 1963a,b with pigeons; Hively, 1962 with primary school children; Moore and Goldiamond, 1964 with pre-school, normal children; and Sidman and Stoddard, 1967 with S.S.N. children) have been aimed at determining differences between discrimination performance during teaching programmes involving, on the one hand, discrimination problems carefully sequenced in ascending order of difficulty to minimize errors (such sequencing being achieved by stimulus 'fading') and, on the other hand, programmes without such sequencing. Two main findings have emerged from such studies. Firstly, programmes carefully sequenced have led, in each study, to the more rapid attainment of criterion discrimination performance on simultaneous, two-choice discrimination problems (Terrace, 1963a,b), matching to sample problems (Hively, 1962; Moore and Goldiamond, 1964) and oddity responding (Sidman and Stoddard, 1967) than have unsequenced problems, and with fewer errors being made. Secondly, it has appeared that allowing subjects to make errors by giving them unsequenced programmes has tended to cause poorer performance in similar discrimination learning problems given later in the programme. These effects have been attributed to the fact that unsequenced programmes permit the subject to make errors which are unwittingly reinforced by the apparatus. Error 'tendencies' would, therefore, be more likely to appear in similar, subsequent problems. The belief of Skinner that performance in teaching programmes should be virtually error-free is thus given direct support by these studies, at least for the teaching of discrimination performance to criterion.

But although the careful sequencing of teaching material would thus seem to have advantages over randomly arranged material, three difficulties would appear to be inherent in its use. Firstly, the time involved in the design of such a programme (Sidman and Stoddard, for example, made six revisions in order to create an optimally effective sequence for their circle-ellipse discrimination programme) is likely to make the development of such programmes extremely costly. Secondly, when produced, they are likely to be effective for only a limited number of children, losing their attribute of effectiveness for children outside their 'target population'. Thirdly, there is no evidence that children do not in fact gain more from the experience of working on a <u>difficult</u> task than on one which is easy for them. That is, that although it may take children longer to reach criterion on a difficult task, the fact that they are being given more of a problem to solve maybe teaching them skills which might prove useful in further tasks. In not examining the nature of children's performance on transfer tasks performed after working on teaching programmes it is possible that the full value of them is being missed. In this respect, the work of the Clarkes on the nature of the transfer of learning shown by the S.S.N. is both interesting and relevant. In several studies, the Clarkes have demonstrated greater improvement in discrimination tasks (a typical task would involve the sorting of symbols or pictures into containers) shown by subjects given pre-training in complex tasks than by subjects given pre-training in simple tasks. For example,, Clarke and Cooper (1966) demonstrated that the variable of task complexity was resonsible for findings that the amount of transfer shown by young S.S.N. persons (aged about 9 years) in discrimination tasks was considerably greater than that shown by older persons (aged 17 years and above). (Clarke and Blakemore, 1961; Clarke and Cookson, 1962). Typewriter key sorting and Minnesota form-board tasks were adjusted in difficulty so that the starting scores of adults and children were the same for each task. This making the typewriter key sorting task harder for the adults to bring their initial score down to that of the children resulted in increased transfer for them to a different version of the same task; reducing the difficulty of the form-board task for the children so that their scores were equal to those of the adults at the outset of the task reduced the amount of transfer shown by them on a similar task. It thus appeared that the greater the initial difficulty (or 'complexity') of a task, the greater was the amount of transfer from it. A second experiment extended these findings (Clarke *et al*., 1966). In this experiment groups of S.S.N. children (average age approximately 12 years) were given picture sorting tasks of differing difficulty, the easiest of which required the sorting of picture shapes of the same shapes but in terms only of their outlines ignoring their *content* which was thus a distractor. After training in these tasks children were transferred to a task involving the sorting of pictures of human beings, animals, furniture, tableware and clothes into compartments labelled with an example of one of these categories. Children thus had to sort conceptually rather than in the purely perceptual manner required by the pre-transfer tasks. Results showed that all children given pre-training did better in the transfer task than did children in a control group who had been given no such training and that children given the two more complex training tasks learned the transfer task with fewer errors than children given pre-training with the simplest training task. Moreover, in each experimental group of children, children showing low initial performance showed greater transfer than children with high initial performance. Difficulty could thus be seen as important in determining the amount of transfer to a new task, whether this was defined in terms of how hard different children found the same task or in terms of how hard different tasks were for similar children. In addition, it seemed that transfer had taken place in terms of the children's ability to sort and categorize since, unlike experiments such as those of Clarke and Cooper (*op.cit*.), the training and transfer tasks had little in common in terms of the kinds of stimulus materials used in them.

This is interesting, for it generates the possibility of teaching conceptual behaviour as a 'formal discipline', rather as Skinner and Holland have suggested.

On three counts, therefore, problems exist in the preference of carefully sequenced stimulus material in a teaching programme aimed at producing error-free performance to that of a randomly arranged set of problems. The former are costly to produce, suitable only for a limited number of children as error-free programmes, and possibly educationally rather sterile. On the present evidence if numbers of children are available for the development of such programmes, if development time can be justified, and if it is required that criterion performance be rapidly generated in specific groups of children then error-free programmes are to be preferred to randomly distributed ones. If such conditions do not apply, an argument may be made out for the use of a randomly-arranged set of problems to be used as a teaching programme. Perhaps the main objection to such use is the possibly greater occurrence of incorrect patterns of response under conditions of random arrangement than under conditions of careful fading. It has, however, still to be shown that such patterns of response, ever-present as they are in problem-solving tasks, are inevitably bad. If they do indeed represent facets of the development of problem-solving strategies in the child they should be encouraged to persist rather than suppressed. How best they should be encouraged is, however, a question for further experimentation.

(b) Determining what may be taught

Turning now to the question of what might be taught by matching to sample machines, we shall consider firstly machines prior to the Touch Tutor, which did not employ 'verbal naming', before considering what advantages such a facility may have.

Earlier, we noted the paucity of evidence provided by Skinner and Holland concerning the possibility of using matching to sample teaching programmes to teach skills basic to education such as reasoning and discrimination. The work of Clarke does in some measure remedy this by providing evidence of the possibility of teaching such skills by appropriate practice. The sorting of shapes into containers (a kind of matching to sample task) has led, as we have seen, to improved performance on tasks in which the only similar element was the ability to sort and categorize stimuli. Similarly, Clarke (1970) cited an experiment which demonstrated the possibility of adult S.S.N. subjects acquiring a set for the classification of words presented orally in a list, after training in which the categories present in similar lists were emphasized. This learned set gave rise to the subjects' quicker acquisition of a list which contained words which could be classified but in which the words were actually randomized, in comparison to that of subjects who had not been exposed to training in which the possibility of categorizing the items of a list was made apparent. According to Clarke and Cookson (1962) such tasks appear to give rise to a generally improved 'know-how' about the execution of the task, and to improved perceptual and conceptual discrimination. Other things being equal, it would seem likely that subjects could gain in a similar way from matching tasks presented on machines. There is a need, however, to determine empirically whether this is so. In addition, there would seem to be a need to determine an appropriate curriculum of skills-to-be-taught for, although improved perceptual and conceptual awareness is valuable, it is possible that the S.S.N. have other, more pressing needs. In this respect, work aimed at delineating particular perceptual and cognitive deficits of the S.S.N. or work aimed at determining the main prerequisite skills of particular future careers they may adopt could be of immense importance.

Those machines which employ only matching to sample (with appropriate reinforcement of responses) as their means of presenting information tend to be restricted in the subject matter they can present to the kind of perceptual/conceptual problems we have been discussing. The Touch Tutor, on the other hand, has the possibility of presenting subject matter verbally as well as visually, which may be a most valuable facility. Let us now consider what the machine's advantages are in the inclusion of verbal naming in its mode of operation.

Cleary and Packham have presented little information about what children have gained from hearing the Touch Tutor name stimuli presented on the machine. Their experiments have, however, suggested that the naming acts as a reinforcer for correct responses, in that children have learned to match to sample on the machine while working through matching problems with verbal naming as the reinforcement for correct responses. Moreover, it has been reported that, in the early stages of work with the machine, sweets were no more effective in maintaining responding than were the reinforcements of the slide-change and the machine speaking (Mayes, 1968).

In addition, it has been suggested (Huskisson <u>et al.</u>, 1970) that pre-school normal children will acquire the 'name' of a word shown on the machine in the process of matching pictures to their word equivalents, in that they come to make correct responses to such 'conceptual' matching slides to which it would, if the child could not read the word, be impossible to respond correctly.

More explicit evidence of the possibility of S.S.N. children learning to 'read' words from the Touch Tutor come from a study by the present author and Dr. N.A. Beasley conducted shortly after the first main study reported in Chapter 5 of this volume. 7 children able to match to sample at the end of the study were given further practice with matching to sample material to strengthen their skill and to give them experience of matching stimuli novel to them. Six words were then selected and hand-written in lower-case letters on flash-cards. These were presented twice to the children as a Pre-test, with no knowledge of results, during which children were asked to name the words. Children then worked through 54 matching to sample slides presented on the Touch Tutor in which they were required to match these six words on slides in which the sample item was a word and the correct response was the same word, while the other panels contained similar words as distractors. The words portrayed on the slides were written in 'Letraset' pre-printed transfers. If children responded correctly the machine spoke the word aloud. At the end of the 54 slides the Pre-test was repeated and it was repeated again one day later. Results (Table 9.1) showed Pre-test to Post-test gains in all the children, thereby indicating the possibility of children acquiring the names of stimuli presented on the Touch Tutor in the course of working upon it. Moreover, there was transfer to a non-machine test. This study is also reported by Beasley (1973).

Table 9·1

Numbers of words (out of six) correctly read by seven S.S.N. children before and after working on a sight-reading programme presented on the Touch Tutor

S	Pre-test	Post-test	Retention test
E.W.	2	6	6
C.G.	3	6	6
L.B.	1	3	2
M.G.	0	2	2
P.B.	0	5	4
J.B.	0	2	3
D.B.	0	2	0

A second potential value of the facility of verbal naming is that of encouraging children to vocalize while working on the machine. Harper et al. (1971) noted the tendency of some children to respond vocally to the Touch Tutor while working upon it, naming pictures presented on the machine before the machine itself had done so. Again, little information is available with which to assess this phenomenon from the studies of Cleary and Packham but some indication of how frequently children do this is obtainable from the author's studies of the 'Redcourt' children. 8 out of the 23 children studied during Experiment 3 either named some of the pictures when they appeared on the machine or copied the machine's naming of the stimulus picture.

A third potential value of verbal naming stems from the above. If the machine is capable of teaching children the names of the stimuli which appear on its sample panel, it could be that the machine would be useful in the provision of 'verbal mediators'. As an example of this, an experiment of O'Connor and Hermelin (1959) may be cited. O'Connor and Hermelin presented young S.S.N. children and young normal children matched for M.A. with a task in which the choice of the larger of two squares was rewarded. Both groups learned this in a similar number of trials. On mastery, the smaller of the stimuli became the positive stimulus and the trials were continued to the criterion required for the original learning task. The two groups then displayed differences in their rate of acquisition of the reversal task with the young normal children taking significantly longer than the subnormal children. The authors interpreted this as evidence of a lack of verbal hypothesising in the subnormal children, for whom the second task was merely another perceptual learning problem in contrast to the young normal children who, having acquired a verbal hypothesis about the nature of the solution ("The sweet is under the big square") in the original task, were hampered in the second task. In support of this hypothesis were the results of a second experiment with a different group of S.S.N. children who, when given verbal explanation of the relationship between the reward and the stimuli in the original learning task, took considerably longer to master the second task.

It is possible that similar results could be gained by using the Touch Tutor. Were this the case the machine would again be aimed at the teaching of 'basic academic skills', rather than at the teaching of 'factual' information. Once again, however, the question of the extent of transfer would need to be raised and carefully examined.

To summarize, verbal naming does seem to be a valuable addition to the mode of operation of matching to sample machines. It not only has the function of a reinforcer but also gives the possibility of teaching children the names of written words and objects, of giving them verbal mediators and of encouraging their vocalizations. To realize these possibilities to any degree, however, there is a need for extensive further work to examine what children can gain from such programmes presented on the machine.

(3) Discussion

The preceding discussion of some of the issues relevant to the development of further teaching programmes for the Touch Tutor has revealed that one of the major problems in this area is the lack of information about the effects of possible programmes on the children. Nevertheless, we have been able to determine some ways in which the Touch Tutor might be valuable in the education of the S.S.N. and to what problems further research might turn.

The discussion has, in particular, focussed upon the ways in which children's performance upon matching to sample programmes presented by machines has improved and with what kinds of subject matter such improvement has been found, the extent to which skills acquired on such programmes have transferred to fresh situations, and the extent to which differences in programme performance have been apparent.

It appeared that experience on matching to sample machines could lead to improved matching performance on problems requiring both perceptual and conceptual discrimination and that, while working on such problems with a machine like the Touch Tutor which has a feature of 'verbal naming', children might pick up the names of such sample stimuli as written words or pictures. Evidence upon the extent to which knowledge or skills acquired while working on such programmes might transfer to other situations was slight; however, related work using similar tasks, but not actual machines, suggested that children could acquire three things from working on matching problems of a suitably complex kind, viz., improved general know-how about the nature of the task, improved perceptual discrimination and improved conceptual ability, which would transfer to other tasks. And, on programmes involving the verbal naming of the matching stimuli, there was some evidence that children could transfer the names of objects (as in the acquisition of sight vocabulary).

The discussion raised problems about the way in which programme material should be sequenced. Some workers have argued the necessity of careful sequencing of stimulus material in ascending order of difficulty; others have favoured, without specifically arguing the merits of such a method, random distribution of items throughout a programme. The probable advantage of the former method, which was suggested by the available evidence, was that children may be quickly led to criterion performance on discrimination slides, with the minimization of the appearance of incorrect patterns of response. In contrast, the latter appeared to lead less quickly to criterion, and to be causing the development of incorrect patterns of response. It was, however, pointed out that the development of error-free programmes could be time-consuming, possibly ineffective for subjects outside the 'target population' of the programme, and, since error-patterns would be less frequent, possibly poor training for non-faded problems. To expand on this last point, the S.S.N. child has few carefully sequenced problems placed before him in everyday life, which suggests the need (as Clarke (1970) has done) for providing such people with experience in complex, problem-solving situations. Thus, as suggested earlier, it could be valuable to permit incorrect patterns of response to be developed, rather than to encourage 'spoon feeding' by the programme designer. It is interesting that, in another context entirely, Duncan (1972) commented on a similar difference between two types of training. Industrial trainees (of normal intelligence) given 'algorithms' for locating the origin of contaminant in an acid purification plant were superior in fault location in situations appropriate to the algorithm to trainees given explanations and diagrams of the flow of acid through the plant. They were, however, inferior in the retention of such fault finding and in fault finding in situations not covered by the algorithm. Duncan interpreted this as an example of: "programming performance rather than programming learning" (op.cit., p.33), which is an important distinction. Similarly, the writer has heard Adult Training Centres spoken of disparagingly for using 'jigs', these being blamed for ensuring speed and accuracy of output at the expense of the trainees' skill in counting, discrimination or whatever skills practice in the whole task might generate.

The above discussion of the kinds of subject matter which might effectively be taught by the Touch Tutor and of the best ways in which material might be sequenced could, in some ways, be thought an expensive luxury in relation to the Touch Tutor. For, once a decision is reached about the general format of teaching material, the practical problems of creating the material arise.

Ideas about the potential of teaching machines like the Touch Tutor have been voiced by each of the workers who have used them, without the subsequent appearance of appropriate programme material which could begin to realize such potential. The exception to this has been in the work of Marshall (1969) and Morgan (1971), both of whom have believed strongly in the value of 'programmed instruction' and who, as Headmasters of E.S.N. schools, have been in a position to implement their ideas. More than this, however, they have been close enough to the children and their teachers to determine their particular educational needs and have had the energy to develop a wide range of programmes and suitable machines for the children to use. Particularly important would seem to be the development of a wide range of programmes; both Marshall and Morgan have developed an extensive library of programme material to suit the needs of children with different interests, handicaps and ages.

The teacher may be in the best position to decide upon subject matter for teaching programmes, but teachers must have access to the means physically to make them. In this respect the Touch Tutor and similar matching to sample machines have particular disadvantages. It is important to realize that the majority of the machines mentioned so far in this volume have required the user to prepare visual teaching material on 35mm. photographic slides, a costly process and difficult for the novice. In this respect, the Touch Tutor is no exception, requiring the preparation of art-work of a fair standard, its arrangement into matching to sample format and photography with a camera of good definition. In addition, for the Touch Tutor, the user must be able to record the auditory equivalents of the words on magnetic tape on stereophonic equipment, and then splice and load the resulting recorded tape into an endless loop tape cassette. Care must finally be taken in the mounting of the photographic slides so that the stimuli appear in the centre of the response panels. It is thus a difficult, time-consuming and costly procedure to manufacture programmes for the Touch Tutor, a fact which has to be borne in mind when considering the wider use of the machine. Moreover, once a programme of slides has been made, there should ideally be evaluation and further revision, which again are exacting and time-consuming activities.

These considerations suggest that a machine for which programmes would be physically easy to develop programmes would be an advantage over the Touch Tutor. Even so, there would probably be a need to appoint a teacher to devote time to determining the needs of other teachers for programme material and to making and evaluating programmes accordingly.

(4) Conclusions

In conclusion, it would seem that it is possible to envisage the use of machines like the Touch Tutor for both the teaching of 'academic skills' (for example, 'discriminating') and particular 'topics' (for example, the recognition of words). What is presently lacking, however, is a selection of programmes for use on the basis of the results of which more specific evidence of what such machines can teach might be gained.

Probably the major drawback in the development of such programmes is, however, the technical difficulty of making such programmes which would deter the teacher from putting her ideas for programmes into practice. If this difficulty were overcome, and if teachers were encouraged to devise new ideas for programmes, one could look forward to a greater selection of material for the Touch Tutor. It would then be interesting to pursue some of the 'academic' problems raised in this chapter concerning the learning of children under different programme formats.

Before leaving this discussion, two final points must be made. We have so far concentrated upon matching to sample as a means of presenting teaching material which limits teaching to children able to match to sample. One might ask how far such a machine would be useful to children willing to respond to the machine but who were not able to match to sample. It is possible that the machine would be useful in providing general stimulation to such children and in encouraging sustained responding, rather in the manner of other operant apparatus; in encouraging vocalizations; and, were one-choice slides used exclusively, it might give rise to such children's acquisition of the names of stimuli.

As yet there is little evidence on the extent to which such possibilities could be realized by using such machines in this way (although we shall discuss, in Chapter 10, some evidence on the last possibility); it is necessary, however, to realize that the use of matching to sample machines for this kind of task is wasteful. A simpler machine could provide children with one-choice slides only, at a fraction of the cost of the Touch Tutor. The main reason for this is, of course, the increase in the complexity of circuitry which stems from a need for a machine to discriminate between correct and incorrect responses and to be able to discriminate between 'random' and 'matching to sample' performance over a series of slides.

CHAPTER 10: CONCLUSIONS

This chapter discusses, firstly, some of the developments in the use and design of the Touch Tutor which have taken place while the work reported in this thesis was being carried out. Secondly, it examines the extent to which the aims of the thesis with respect to the proposed Evaluation of the use of the Touch Tutor with the S.S.N. child have been achieved. Thirdly, it discusses the work of the thesis with respect to the wider context of the educational treatment of the S.S.N. and, more particularly, the part the Touch Tutor and machines similar to it are likely to play in this treatment.

(1) Recent developments in the use of the Touch Tutor

For reasons of clarity the author has not described some of the work using Touch Tutors which has taken place since the present work began. This omission will now be rectified.

By March 1971 some 20 Touch Tutors had been sold in Britain, mainly to schools or research bodies concerned with E.S.N. or S.S.N. children (Cleary and Pakham (1972). Information about the use of only some of these machines has come to the present author, however.

Some 3 machines had been used under the auspices of the Hester Adrian Research Centre in Manchester by Mr. C.C.Cunningham. One machine had been used by Mrs. Freda Levinson at Harperbury Subnormality Hospital. Some 5 machines were under the general supervision of Mr. D. Moseley of the National Society for Mentally Handicapped Children and other machines had been used by the research team of Cleary and Packham. Since March 1971 the situation has begun to change, so that at the time of writing, (January, 1973) the work of Cleary and Packham, Levinson and Moseley has virtually ceased, while that of Cunningham has reduced, as far as the present author is aware.

After 1968 the originators of the Touch Tutor continued to develop the machine, following two major lines of progress (Cleary and Packham, 1972). Firstly, methods of reducing the number of incorrect responses made by subjects by machine-based (rather than by programme-based) cues were explored. Secondly, work was directed at the testing of the transfer of knowledge by children from the machine to a text and at the development of programmes to teach number concepts.

Two means of cueing were devised. One involved the progressive dimming of the incorrect response alternatives, as the number of errors made by a subject increased. Thus, immediate correct performance on three-choice matching to sample slides resulted in no cueing but as soon as errors began to occur the incorrect response stimuli started to dim. The other means of cueing involved the naming by machine of the sample stimulus on the appearance of a slide, the loudness of this varying with the number of errors made, rather in the same way as in the visual cueing.

The two types of cueing were tested on fifty six normal children aged between 4 years 4 months and 5 years. Children were initially given no instruction in matching to sample and were allowed to work on the Touch Tutor for 8 sessions. Under each condition of cueing children were allocated randomly to one of four conditions, which were differentiated by the performance level at which cueing was terminated. These levels were: 55%, 69%, 79% and 86% responses correct. On the first session the initial performance level was set at the cueing level for that condition (e.g. 55%) so that no children would begin with the full matching task. At the end of each session the performance level of each child was noted and used as the starting level for the next session. The same procedures were used for the auditory cueing conditions.

The results appeared to indicate to the authors that auditory cueing was more effective than visual cueing in raising the children's performance towards the predetermined levels. Although the general characteristics of the children's performance under the two conditions were similar, the average number of slides taken by children in the auditory cueing condition to reach the final performance levels was approximately half that taken by children in the visual cueing conditions. A high correlation between initial performance and the predetermined level appeared in the auditory condition which seemed to the authors to point to the effectiveness of the cueing. No explanation for these effects, or any discussion of the results or implications of the developments were offered by the authors.

As with the above studies, the work directed at the testing of machine-to-text transfer was not reported in complete detail in the above report of Cleary and Packham. However, in a complex experimental design, 13 children were given the opportunity to work on programmes of words and phrases based on the material contained in the first two books of the '<u>Ladybird</u>' Reading Scheme. The children, who were aged approximately 5 years and who had had no formal training in reading, were divided into two groups. The two groups both received pre-training with the "-1" pre-reading series of slides prepared by the authors, followed by pre-tests on flash-cards of words from the Ladybird books. A cross-over design was then employed to assess the effects of the programmes based on the Ladybird books against the existing programmes in the reading series of Touch Tutor programmes (programmes "0" to "+4"), as measured by the repeat of pre-tests. Unfortunately, the results of this study were not reported. It is,therefore, impossible to determine whether children did acquire the words and whether they were able to transfer their knowledge from machine to text.

With regard to the development of programmes involving number concepts a brief description of these was contained in Cleary and Packham (<u>op.cit</u>.) but no description of results obtained with these programmes was given.

Cleary and Packham have ceased developing the Touch Tutor. According to Cleary (Personal Communication, 1971) the response of educationalists to the Touch Tutor was disappointing, one of the main factors in this appearing to be the cost of the machine. In a similar vein they noted:

> "The machine we designed is, of course, too expensive for use on any scale in primary education, so perhaps we should devise cheaper, less complex systems..." (Cleary and Packham, 1971, p.8.)

However, they saw some value for the machine in the future:

> "As far as future developments are concerned, the machine seems to have found a limited but useful function in the education of subnormal children and as a research tool in psychology."

and believed that:

> "it is likely that the Touch Tutor and similar machines will be used increasingly for teaching subnormal children (see Levinson, 1970b)." (<u>ibid</u>.)

The work of Cunningham (1970 and Personal Communication, 1971) focussed upon the use of the Touch Tutor for the assessment and subsequent remediation of visual deficits in S.S.N. children in Special Schools in the community (excluding children in Special Care Units). Cunningham's approach was to use cards containing stimulus material for his initial work with the children so that their matching to sample skill could be developed and initial problems (such as shyness) overcome. His mode of instructing matching to sample was eclectic but principal components were encouraging children first to point at objects on command and then encouraging them to find objects which were the same or to point first to the sample stimulus and then to 'find one like it'. As far as the present author is aware, however, Cunningham used no method exclusively; for example, with some children a series of sequenced matching problems similar to those used by Hively (1962) was used.

Unfortunately, the results of Cunningham's work are unclear. Using the cards in a face-to-face situation it appeared that:

> "The vast majority of children could solve match to sample problems... or could be trained to do so." (1970, p.27)

and Cunningham (1971) believed that 95% of children in 'Junior Training Centres' were able to match to sample. However, it was not clear whether Cunningham allowed children to work completely unaided. Where children failed to touch the matching stimuli it appeared that he would sometimes point to the sample stimulus. Since his primary interest was in testing the children's discriminatory capacities, this was a legitimate procedure for him to adopt.

Cunningham (1970) presented a profile of scores for S.S.N. children on match to sample tests involving discriminations among real objects, geometric shapes, objects varying in size, in rotation and in apparent distance presented on cards as described above. A group of 30 such children obtained scores on these tests which suggested a hierarchy of difficulty of discrimination in the same order as these attributes are mentioned above, with the perception of distance being the hardest discrimination. Individual profiles for two children were presented, however, revealing for one child an apparent deficit in size discrimination and for the other one in the discrimination of rotation.

Levinson (1970a,b) used the Touch Tutor with some of the children in a subnormality hospital. Children were given initial instruction and demonstration in the use of the machine and were then left alone. Of 12 children (whose I.Q.'s ranged from 20-50 and whose C.A.'s ranged from 7 to 14 years) selected from a pool of 35 who were considered likely to respond to the machine 4 reached criterion on at least one of the makers' series of slides. However, the remaining children seemed disinclined to touch the machine and were unwilling to remain alone with it. Accordingly, there seemed a need to encourage children to stay on their own with the machine and to establish touching firmly before introducing matching slides. To achieve these two aims, a programme of slides in which the same stimulus appeared on each response panel during a slide was made, so that children would receive auditory reinforcement for every response to the lower touch panels. Trials with this programme were made with 11 children (of whom 8 were 'unsuccessful' children from the earlier studies). All children seemed more content to stay with the machine and the rate of touching was improved in 8 of the children. As might be expected, however, when children were switched to a matching to sample programme it appeared that they had learnt to ignore the stimulus panel.

Further work was needed, it seemed, to develop suitable reinforcers for these children; the specific nature of this work is not mentioned, however. Levinson's concluding comments ring a familiar note:

> "An unanticipated bonus was provided by our clinical observations of the children in this situation. We were frequently surprised by the extent of their capacities, as they frequently showed skills which had never been demonstrated during conventional methods of assessment. If we can systematise these kinds of observations, the Touch Tutor and similar devices could play an important part in general clinical assessment." (1970b, p.11).

The majority of the Touch Tutors under the general direction of Moseley (1970a) were purchased by voluntary fund-raising organizations and were in use in Junior and Adult Training Centres. Wherever one of the machines was installed, teaching staff were instructed to keep records of the number of touch responses children had made in a session and of the level of performance as indicated by the performance meter. If staff shortage meant that a Touch Tutor could not be fully used, arrangements were made for volunteer workers to sit with the children. Moseley (op.cit.) planned to produce and validate at least 6 programmes for the machines. Some of these were aimed at the matching of pictures relating to 'social competence' skills (e.g. brushing the teeth) while others were aimed at the matching of letter-, vowel- and consonant-shapes. It was aimed to record the progress of children on appropriate language and social competence tests who had been exposed to the Touch Tutor programmes.

At the time of writing no information concerning the outcome of these plans was available to the author. He had, however, spoken to a teacher from one of the schools in which a Touch Tutor had been placed. She spoke of the machine with interest and enthusiasm but pointed out that the machine was of limited use in her particular school. Because it had been a gift from a voluntary organization the machine had been put in a special booth and suggestions that it should be placed in a classroom ignored. Accordingly the teacher had to leave her class and take one child at a time to work on the machine, which seemed a drawback to her. Moreover, the programme material for the machine was much too limited; her children were forced to work through the two picture matching programmes continually and were becoming too familiar with them.

Finally, developments in the manufacture of the Touch Tutor are of interest. Kapota (1970), acting on behalf of Behavioural Research and Development Ltd., noted that:

> "after four or five years the company has produced sixteen machines at a heavy loss... it is estimated that the sale of 200 machines over the next two years is necessary if we are to recover our losses."

Since this level of sales was believed impossible, the machine was re-designed in solid-state form in order to make it compatible with the range of solid-state modular programming equipment then produced by the company. This new machine (the Touch Tutor Mark IIM) was re-priced at £650 and contained one new feature - a more flexible system of auditory feedback using an 8-track tape cartridge making, among other things, it possible to record auditory messages of any length. Few of these machines appear to have been sold.

During 1971 Behavioural Research and Development Ltd. went into liquidation, since when the machine has been marketed by Contract Services Ltd. of Newcastle upon Tyne and, more recently, by Thompson and Watson of Newcastle upon Tyne. The price and design have remained unchanged. The machine is now manufactured to order by the last-named firm and it is possible to lease the machine, with programmes, for approximately £18 per month for a four-year period.

(2) Discussion of the thesis

It is now necessary to examine how far the thesis has succeeded in its aim of evaluating the use of the Touch Tutor (and of similar machines) in the education of S.S.N. children. It will be remembered that information was primarily required on the five 'pre-conditions' of the use of such machines. Let us therefore begin this section by discussing the present work in the context of these five points of information.

Point 1: "<u>that a machine appropriate to Skinner's aims is available for use.</u>"

The Touch Tutor has been seen to be very similar in design and in its mode of operation to the machine which Skinner himself designed for young normal and for handicapped children. Since it is still commercially available it must fulfil the obvious terms of this first pre-condition of use. However two reservations, which refer to its practical use, must be noted.

Firstly, at the time of writing the machine did not have, and had not had since its appearance, appropriate programmes for fulfilling Skinner's maxim that children's behaviour should be shaped from what was known by the child to what the teacher desired him to know, by programmes in which errors were few and reinforcement frequent. Secondly, the phrase "available for use" pre-supposes that commercial availability (a problem before the appearance of the Touch Tutor) is equivalent to availability to the teacher. The price of the Touch Tutor and of programme material for it would be likely to make the machine (or a supply of programmes) unreachable by many teachers.

Point 2: "<u>that children will find such a machine attractive to use.</u>"

The present work found that some 50% - 60% of children in two samples responded to the Touch Tutor consistently over the course of studies lasting two to three sessions of some 10 - 20 minutes in length. In one study (Experiment 1) it was found that, in addition to 50%of the children studied responding to the machine consistently throughout the study, a further 21% of the children responded to it at some stage of the study but not at other stages. Analysing the responses of children in greater detail, it was found that the mean response rates of children in the two samples were similar. Both samples completed on average some 4 to 5 slides for each minute children had spent with the Touch Tutor.

Some of the children from each sample took part in further studies with the Touch Tutor. In one of these (Experiment 2) children who had responded correctly to the one-choice slides only during Experiment 1 were studied over five further sessions of some 8 minutes in length. During this time the group continued to respond well to the Touch Tutor, with the exception of one child who could be induced to make no responses to the machine and of one child who began to lose interest in the machine as the sessions continued. Similar findings occurred in another study (Experiment 4) in which children who had taken part in an earlier laboratory study of their responses to the Touch Tutor (Experiment 3) were given the opportunity to work on the Touch Tutor in a classroom setting. The Experiment continued for a brief period only so that the majority of children received but one session with the machine. Again the machine remaindd attractive to the majority of children in that they were willing to work with it for periods ranging from below five to above 55 minutes (median 15 minutes) during which below 40 to above 200 slides were completed (median 79 slides). During this period it also seemed that some 5 children had begun to respond to the machine who had not done so in the earlier, laboratory studies with those children. This meant that during the Post-test screening of Experiment 4, 84% of the children responded to the Touch Tutor.

It is not possible to say whether these figures indicate that the Touch Tutor is, for example, "highly attractive" or "unattractive" to such children as were studied in these experiments, for there is no norm of "attractiveness of educational material" available for these children. All that can be said is that the present findings offer, firstly, data against which the attractiveness of other educational apparatus (as measured in some way comparable to that done in the present studies) could be set. Secondly, they indicate the extent to which the Touch Tutor might initially be used with children similar to those studied here.

It must, before leaving this aspect of the machine's use, be emphasized that the above conclusions should be seen within the perspective of the experimental procedures adopted for the experiments. Thus, only children in residential care have been used; secondly, the studies have been of a short term nature in comparison to the length of time the machine could be used were it installed in a suitable school; thirdly, children have been given rather more attention (particularly in the laboratory studies) than might be the case if the machine were in regular use in a classroom setting; and, fourthly, limited attention has been paid to ways of inducing non-responding children to respond. Let us consider each of these four factors in turn.

With regard to the first factor, it is possible that children in residential care suffer a more impoverished intellectual and emotional life than children who attend day Special Schools in the community. Accordingly the former might respond to the presence of a new toy more enthusiastically than the latter.

With regard to the second factor, it is possible that the present studies were too short to give an accurate picture of the machine's attractiveness relevant to school situation requiring children to respond to the machine over, say, several months. Were the machine used with a limited selection of programme material over a period of months it is possible that children would lose interest in the machine (although some children might continue to respond to it favourably and others might begin responding to it who had not hitherto done so) but one might expect the use of an interesting selection of programmes to offset boredom.

With regard to the third factor, it is possible that the presence of the Experimenter in the laboratory with the children increased their responsiveness and concentration on the task. It is, however, hard to see that this was indeed the case, for the majority of children performed with little encouragement or intervention from E. It is true that some children almost certainly would not have responded had the Experimenter been totally absent, but this would probably have been due to feelings of fear which would not be so strong (one would expect) in classroom settings. Moreover, the presence of a familiar figure is typical in the normal classroom setting.

With regard to the fourth factor there were instances in both Experiments 1 and 4 of children beginning to respond to the Touch Tutor who had not done so before. This raises the question of whether more children could be induced to respond to the machine and, although there is no direct evidence of this, it is possible that continued exposure to the machine could increase the numbers of children responding to it as could, no doubt, the planned use of reward.

Point 3: <u>That children possess the skills required to operate the machine</u>

The present work suggests that considerably fewer children than those responding to the Touch Tutor are able to match to sample on it in the initial stages of use with the machine. Experiments 1 and 3 yielded similar percentages of children responding correctly, with Experiment 1 yielding figures of 12% of children matching to sample on two-choice slides and a further 36% of children responding to one-choice slides correctly and Experiment 3 yielding figures of 14% and 45% for the two types of slide. The results of Experiment 1 showed some variability in matching to sample with different types of slides. Thus, although 10 children reached the criterion level of 8 out of 10 slides correct on at least one series of slides out of the 30 possible (comprising ten two-choice black-and-white slides, ten three-choice black-and-white slides and ten three-choice slides depicting 'nonsense shapes') there were only 6 children reaching criterion on the two-choice slides, 7 on the three-choice slides and 6 on the nonsense shape slides, indicating some instability of the behaviour. Only two of these children reached criterion on all three series, while five reached it on both 2-choice and on 3-choice slides and four on both 3-choice and on 'nonsense shape' slides. Thus, estimates of the numbers of children matching to sample could range from 2 to 10, depending on the basis of the estimate adopted.

During Experiment 2 some children who had responded to one-choice slides correctly during Experiment 1, but not to matching to sample slides began to match to sample on two-choice slides. Four of these children did so at the beginning of the Experiment and a further two did so in the course of it. Adding these six children to the number of children who had matched slides correctly during Experiment 1 shows that, by the end of Experiment 2 some 12 children had shown evidence of matching to sample on two-choice slides. Adding the four children who had shown criterion matching on either three-choice or nonsense-shape slides but not on two-choice slides shows that 16 children (32% of the total sample) had shown a minimum level of matching performance during Experiements 1 and 2.

During the Post-test of Experiment 4, nine children reached criterion on matching to sample slides (three-choice slides were used) which was 38% of the 24 children studied; a further ten children (42%) reached criterion on one-choice slides only.

Thus, by the end of Experiments 2 and 4, approximately one third of the samples of S.S.N. children studied had, after periods of work with the Touch Tutor lasting between, on average, thirty minutes and one hour, shown evidence of criterion matching to sample performance.

Of the two samples studied, children who took part in Experiment 4 appeared to have a much more stable matching performance than children who took part in Experiment 1. Thus, in the Post-test of Experiment 4, all children transferred their criterion matching performance from the first 20 to the second 20 slides of the Post-test, whereas variability between the Post-test sections of Experiment 1 was marked.

The cause of the difference between the two samples is not clear, but it is possible that the training experiences of the children in Experiment 4 were not only more consistent than those of the children in Experiment 1 but were also more varied - leading to better transfer from Training to Post-test. Also, however, for children in Experiment 4 there was a shorter gap between the Training slides and the Post-test, the Training and Post-test slides were more similar in format, and, perhaps most important of all, the children had probably received some verbal explanation from the teachers of the matching principle underlying the slides which could have helped stabilize the performance.

As in the case of the variable of the machine's attractiveness it is entirely possible that more than one third of children could come to acquire the principle of matching to sample on the Touch Tutor if given either further practice on the machine or if given training aimed specifically at the skill. It is possible, too, that an efficient training system could be devised which would increase the numbers of children responding to the machine in this way and which would decrease the time children would need to do this.

Nevertheless, one must bear in mind that children frequently have shown the presence of incorrect patterns of response upon the machine which may interfere with the appearance of correct matching to sample and which may, with repeated practice on the machine, become increasingly rigid. In particular, children with rigid position habits may be highly resistant to training in matching to sample. This area requires further study, however, in order to clarify the relationship between incorrect patterns of response and the appearance of matching to sample in the long term use of a machine like the Touch Tutor. For the present, it is perhaps sufficient to say that, unless particular care is taken in the teaching of the principle of matching to sample and in discouraging the various incorrect patterns of response, a comparatively small number of children will initially use the Touch Tutor correctly. This number may increase, however, with further experience of the machine by the children. The limit to the number of children who could use the machine correctly is not known, but it is possible that some children could still be unable to match to sample correctly after long periods of instruction and practice.

Point 4: "<u>That teachers are able to use the machine in their classrooms</u>."

Experiment 4 suggested, with some slight reservations relating to exactly how the machine was used by the teachers in that experiment, that teachers could incorporate a machine like the Touch Tutor into the everyday classroom situation without major disruption. Children appeared to want to use the machine while other activities were proceeding in the classroom and other children appeared to .find the presence of the machine undisturbing.

Thus it would seem possible for the machine to be used as another piece of classroom apparatus, without the need for special booths to be built to house the machine and (apparently) without the need for teachers to sit with children continually.

However, two limitations to these conclusions must be noted. Firstly, there seemed some evidence of an unwillingness of teachers to use the machine of their own accord. If this were widespread the machine might remain in a classroom without children being given the opportunity to use it. Secondly, the design of the classroom area of the school used in Experiment 4 was such that each class could use the machine without it being moved. For use in other situations, therefore, the addition of wheels to the machine might be necessary.

Finally, the lack of programme material for the machine seemed a disadvantage and it seemed difficult for teachers to create further material. This (and other factors, such as minor mechanical faults) suggested the advantage of appointing a person to over-see the use of a machine like the Touch Tutor.

Point 5: "<u>That sufficient programme material is available for the machine</u>."

We have seen that very little programme material was available for the Touch Tutor, a limited choice of picture-matching and 'reading' programmes being the only ones available commercially. Moreover, although it seemed possible that the machine could teach such skills as 'discriminating' or 'reasoning' and particular topics, such as, for example, sight reading of simple words, the manufacture and testing of appropriate programmes seemed to be too difficult to be able to use the machine on a wide scale. Certainly, it seemed that teachers would not normally have the skills required or access to the equipment necessary to make such programmes.

(3) Conclusions

(i) General limitations of the present work

In discussing the five points of the 'Evaluation' we have seen something of the limitations of the present work with respect to its broad aims. Before moving to a discussion of how the Touch Tutor and machines similar to it may be seen in the wider educational context of the treatment of the S.SN. child it is important to note some of the more general limitations of the work. The first of these is undoubtedly the sampling of the children used. Children attending day Special Schools in the community have not been studied and it is difficult to say how far the results obtained would apply to them. If it is true that children in residential care have presented severer problems of management, and if it is true that children living at home with their parents enjoy a more enriched environment then there are grounds for believing the children studied in the present work to be operating at a lower level of attainment than children in Special Schools in the community. How much lower they are in functioning is, however, impossible to say; as far as the present writer is aware no strict comparisons of children in hospital schools with those in day special schools has been made. However, such a limitation of sampling would not be expected to have caused major qualitative differences in the results. Most probably, it would have caused under-estimates of the numbers of children responding to and able to use the machine correctly which, in any case, are subject to many criticisms on the grounds that more 'effective' methods could have yielded vastly different estimates.

Turning now to the question of the effectiveness of different methods (and commenting no further on the question of sampling error - which applies to other aspects of the work - such as the representativeness of the teaching staff of Experiment 4), the main question which must be raised is whether any major inadequacies were present in the experimental procedures which could seriously have reduced the numbers of children responding to the machine or responding to it correctly. This is a difficult question to answer since there is little comparable data which has been obtained under different conditions of incentive and instruction. The writer is inclined to the view that the present estimates are as good as could be obtained with any other fairly rigid method, a view which is based on the discussion of this problem during Chapter 5. However, he accepts the possibility that the work of Cunningham suggests, that a competent teacher using a mixture of methods suggested by the needs of the child could vastly increase the numbers of children matching to sample and responding to the machine. In defence of the present work, on the other hand, not only does comparable data to other studies seem to have been obtained (see Chapter 5) but the techniques used were simple enough to be passed on to anyone likely to use the machine. This is not intended to be a defence of ineffective techniques, however, as much as the provision of a predictable starting-point for the practical, everyday use of the machine.

A third limitation concerns the use only of the Touch Tutor for the studies. It is possible that the results do not apply to other matching to sample machines. The present writer would argue that, despite differences in design, there were many similarities between the responses of children to the machines in Chapters 2 and 3 and those of the children in the present work. This suggests that the Touch Tutor had a generally similar effect to that which other machines would have had.

(ii) Matching to sample in non-machine situations.

Cunningham's work raises the question of whether the use of a non-machine matching task would increase the number of children matching to sample. Let us now consider whether this is a real possibility with children similar to those used in the earlier experiments with the Touch Tutor.

There are a number of studies in which children have been required to complete form-boards, to sort typewriter keys or to place cards into appropriately labelled boxes (Clarke and Blakemore, 1961; Clarke and Cookson, 1962; Clarke and Cooper, 1966; Clarke et al., 1966). These experiments showed that S.S.N. children had little difficulty in matching to sample. Again, a matching task displayed on boards (Wilcock and Venables, 1968) presented S.S.N. children with few problems. Thus, there appears to be a discrepancy between the results of the present studies with the Touch Tutor and those which have used non-machine, matching tasks. The possibility arises that, far from the matching to sample teaching machine being a superior form of presentation, it is actually less effective than 'unsophisticated' apparatus. Accordingly, a simple experiment was carried out as a first step towards comparing the two.

The clearest indication that children can have little difficulty in completing non-machine tasks successfully is given in the study of Clarke et al. (1966). 36 imbecile children, with an average age of just over 12 years and an average I.Q. of approximately 35, drawn from a residential institution and a day training centre, were asked to place series of 20 response cards into five categories. Three experimental conditions were created, in which the difficulty of the sorting task varied. Thus, some children were asked to sort pictures of large shapes, filled in with achromatic content, while others were required to sort the same shapes but without the achromatic content and with the shapes on the response cards differing from those on the stimulus cards in both size and orientation. Finally, some children were asked to sort on the basis of shape, with achromatic content acting as a distractor. The apparatus used in the experiment consisted of a panel holding the five stimulus cards, each with a box below, the floor of which could be lowered by levers at the side. A red light bulb was fixed in each box immediately beneath the stimulus card. Subjects were seated in front of the apparatus, put at ease, and shown two cards being correctly placed in the apparatus. After each correct placement, the light flashed and the card dropped out of sight. The subject was then told: "I want you to put all the pictures I give you into their proper places."

After each correct response, the red light shone and the experimenter said, "Good". Incorrect responses resulted in a "No", the red light remained out and the card stayed in view. In such cases the card was returned to the subject who was then required to try again. If a correct response was not obtained in five attempts, the experimenter placed the card in the correct compartment and offered the next response card.

The results of the experiment provide a clear indication of the ease of the task for these children. Firstly, it is stated (p. 123) that it was rare for a correct response not to occur within five attempts. Secondly, 13 correct first placements out of 20 were made, on average, by the group having the most difficult task (which required sorting by shape with content as a distractor), while an average of 19 correct first placements were made by the group with the easiest task. These results occurred on the first training trial of each experimental group.

Thus, we have data upon the ease of these three sorting tasks for children as training commenced. It appears that children were already responding at an above-chance level at the outset of the experiment, indicating their grasp of the essential nature of the tasks. In the light of this let us consider the responses of children similar to those who took part in Experiment 1 to a sorting task of this kind.

Subjects. 10 children attending the subnormality hospital school from which children were drawn for Experiment 1 were selected randomly from the 42 on the school register. The chronological ages of these children ranged from 11 to 17 years, mean 13.7 years. I.Q. data was available for only four children, their I.Q.'s being 37,23,20, and 15. 2 of the remaining children failed to score on the Stanford - Binet test; the remainder had not been tested. No attempt was made to exclude children with behaviour problems, sensory defects or other handicaps (although none of the children was considered to be blind) since they were intended to form a cross-section of the school population. No child had taken part in any previous experiment with the Touch Tutor.

Task. The six, black-and-white, line-drawn figures used in the earlier experiments were re-drawn on white cards measuring $2\frac{1}{2}$" x 3" and a sample of each was attached to the front of a plastic box $4\frac{1}{2}$" high x 4" square. The children were required to sort 36 cards, one at a time, correctly into the boxes.

Procedure. Children were brought into the experimental room and seated before the receptacles, which were arranged in a semi-circle. E. showed one of the cards to the subject and said, "Now, --- (name), Watch me", whereupon he slowly placed two cards in their boxes. These cards were then replaced with the remaining cards, S. was handed a card at random and told, "Now you do it. Go on." If S. placed the card correctly E. said in an enthusiastic voice, "Well done" or "Good". If the card was placed incorrectly, E. said "No" and immediately returned the card to S. who was required to try again. If six consecutive incorrect responses were made E. demonstrated the correct placement of the card and handed S. a new one.

Sessions continued until S. had correctly sorted the 36 cards, or until 10 minutes had elapsed, whichever was the sooner. However, if children were responding frequently, sessions were not ended until either a correct response or six incorrect responses had been made to a particular card. Children were given 20 sessions of training each on, administrative conditions permitting, consecutive days. In the main, children were given two sessions per day. To reduce the possibility of rote learning, the position of the boxes was changed each day and the cards shuffled before each trial.

Results. Summary results of the Experiment are given in Table 10.1. Full results are given in Appendix 5. Table 10.1 indicates the ratio of the number of correct first placements of cards to the total number of cards completed. The latter figure is, of course, an index of response rate.

The most marked feature of Table 10.1 is the fact that only one child (C.H.) shows acquisition of the task. In fact, his performance improved steadily from sessions 1 to 3, so that by session 4 his performance was completely correct. Thereafter, his sorting times decreased until he was taken ill after his seventh session. A.W., K.B. and C.N. seemed to begin the experiment at criterion performance; the remaining children showed little change in the course of the experiment.

Table 10.1

Performance of 10 S.S.N. children in a simple sorting task.

Session	1	5	10	15	20
S.					
A.W.	36/36	36/36	35/36	35/36	35/36
K.B.	36/36	35/36	33/36	36/36	36/36
C.N.	36/36	36/36	36/36[1]	*	*
C.H.	0/1	33/36	36/36[2]	*	*
L.P.	3/9	1/6	0/2	1/6	1/5
M.M.	0/1	0/6	0/2	1/5	1/5
T.J.	1/7	3/6	1/5	1/5	2/7
J.M.	1/1	1/1	0/2	0/2	0/2
M.D.	1/1	1/3	**		
P.W.	0/0	0/0	0/0	0/0	0/0

Key: * Sessions ended owing to illness.
** S. refused to continue.
[1] Session 8.
[2] Session 7.

In the Table, the first figure refers to the number of correct first placements of a card (maximum possible 36), the second to the total number of cards actually completed.

The general behaviour of the children during the experiment deserves comment. A.W., K.B. C.N. and C.H. were co-operative children who worked steadily at the task and who responded to the experimenter's verbal comments of "Good" and "No" etc. L.P., M.M. and T.J. were co-operative, but verbal control of their behaviour was difficult. These children were typically impulsive and placed cards quickly, without appearing to look at the pictures drawn upon them. However, sometimes they would only place the cards after repeated encouragement to do so, particularly as the experiment proceeded. They also appeared unaffected by E.'s correction after incorrect responses. J.M., M.D. and P.W. were most difficult children who repeatedly would not co-operate.

These results are reminiscent of those of the earlier studies with the Touch Tutor. 4 out of 10 were able to match to sample in this card-sorting task; earlier, one third were able to do so with the Touch Tutor.

The similarity of the responses of children in the present study to those of earlier ones is apparent also in the appearance of response patterns in some of the children. L.P., for example, developed a kind of Subsequent responding, in which she placed cards successively in each of the boxes. M.M. developed a type of Position responding in which cards were rarely placed in the end boxes. T.J. and L.P. occasionally showed 'Win-Stay' behaviour in which responses were made to the previously rewarded position.

Discussion. One question which springs immediately to mind is whether this sample of children was truly representative of the other children in the Hospital School. As a check on this, the writer interviewed the children's teachers after the experiment and asked them four simple questions about the children in their care. Firstly, they were given a demonstration of the task and asked which children in their class had ever done a similar task without actual assistance. In reply to this, it seemed that 8 children in the whole school (19%) were able to do such a task (this figure included, in fact, the four from the present study who responded correctly) while a further four were believed to be possibly capable of it, given instruction (one of these was the child T.J.). On this basis, the finding that four of the sample of 10 were able to match correctly is, if anything, an overestimate of the number in the school.

Secondly, teachers were asked how many children would replace the cards in any box, if encouraged to do so. 21 children (50% of the school) fell into this category and a further four children were believed to be capable of doing this with just one or two cards, before losing interest (6 of the children in the present study were included in these 21; J.M., P.W., T.J. and M.D. were not included). On the basis that 7 of the children studied fell into this second category, the results are again a slight over-estimate.

Two further questions were asked to gain a fuller picture of the children. 11 children were thought capable of responding correctly to the verbal command to place a particular picture in one box, e.g. "Put this --- (name of picture) with the other --- (name of picture)", while a further three were thought 'possibly' capable of it, given training. 22 children were thought to be capable of placing a card in a given box pointed to by E., with a further two who might perform the task with instruction. 9 children in the school, it may be noted, were placed in none of these categories.

Therefore, it would seem that the present findings are probably not an underestimate of the matching performance of the whole school.

The experiment seems to indicate that the matching behaviour of the children used in this and in the previous studies in the present work was considerably poorer than that of the children studied in the experiment of Clarke et al. (op. cit.) and in similar experiments. Even after extensive training with, objectively, easily-discriminable pictures, six of the ten children studied were unable consistently to make correct responses within six attempts at a particular card. This is in marked contrast to the study of Clarke et al., which noted such occurrences as "rare". We may therefore conclude that the estimates of our studies with the Touch Tutor were not simply due to the use of a machine - presented task. Rather it is likely that the results were due to the low developmental level of the children used, some of whom would have fallen certainly into "idiot" grade as did many of the children in this experiment. In contrast, the studies cited earlier used "imbecile" children.

Finally, it may be valuable to reflect upon specific reasons for the failure of children to learn. J.M. and M.D. were children with marked "behaviour problems". J.M. occasionally became violent when brought to the testing room and occasionally threw tantrums. Therefore, many more sessions were attempted than actually took place. When induced to sit she would either persist in playing with some toy she had picked up or would stare placidly into space. By session 12 her responses had reduced almost to zero, despite every attempt at encouragement and command. The writer therefore began formal operant conditioning with a view (a) to maintain sitting still and (b) to increase response rate. Smarties were then given, clearly contingent upon correct responses, and for no other reason. Despite J.M.'s passion for Smarties, only a temporary increase in performance was gained.

Clearly, the possibility of rewarding correct responses is not possible if they do not occur; therefore, a main reason for non-learning in some of these children is low response rate. M.D. presented a similar problem to J.M. P.W. developed a rigid, tantrum-like state if he was prevented from continuing his ceaseless, stereotyped hand-waving and hence also made no sorting responses.

The children with better response rates (T.J.,M.M. and L.P.) were prevented from learning by their reluctance to look at the stimuli on the cards. Although these children seemed able to discriminate between solid objects they showed no evidence, in or out of the experimental situation, of discriminating between pictures. These children seem to be at an analogous stage to children given extremely difficult discriminations to solve, when response patterns predominate in performance.

Conclusions. The results of this experiment show that the numbers of children in the hospital school studied,able to match to sample, is similar in both machine and non-machine situations. The apparent discrepancy between the earlier results of this thesis and those of studies such as Clarke *et al*. (1966) would seem to be due to differences in the subjects used. Let us now turn to the two brief concluding sections of this work which discuss the Touch Tutor in the context of the wider educational facilities for the S.S.N. child.

(iii) The Touch Tutor in use?

The present work would seem to suggest that the Touch Tutor could, initially, be attractive to the majority of children in Special Schools and usable correctly by some of them. With further experience on the machine it would appear that these numbers could be raised but it is not clear for how long the machine would remain attractive if limited programme material were available for it. Teachers, it would seem, could use the machine in a classroom setting with little disruption.

These considerations are positive ones; they do not deter one from the belief that a machine such as the Touch Tutor could be valuable in the education of the S.S.N. child. But the problem of an adequate supply of programme materials is something of a deterrent. For, without a varied range of suitable programme material children would not only become bored with the machine but, more importantly, would learn little from it.

It is true that this would not be a major deterrent to purchasing a Touch Tutor if the machine were of value without a wide range of programme material. And, certainly, it could have some value at least with only a limited range of programmes in, for example, encouraging children to vocalize, in giving them visual stimulation, in encouraging active responding, in teaching matching to sample or in occupying children without the presence of a teacher.

However, although it would seem likely that the Touch Tutor would have these educational advantages it is important to consider whether these advantages could be obtained more cheaply, either by existing apparatus or by a cheaper machine. For although the Touch Tutor's price compares favourably on paper with that of a human teacher the cost is nevertheless high in comparison to the cost of 'more conventional' apparatus.

The present writer has had the impression that the Touch Tutor can be more attractive to many S.S.N. children than conventional apparatus. 'Novelty value' cannot be ruled out as a major cause of this but the brightness and vividness given to the stimuli by virtue of the projector lamp and the 'digestible' nature of the auditory feedback, together with the responsiveness of the machine to the child's touch, would also seem to be important factors. It might well be that a suitably controlled study would reveal that conventional apparatus competes favourably with a machine like the Touch Tutor for the children's attention, of course. Nevertheless it is noteworthy that Norris saw fit, in a discussion of the educational activities of Training Centres, to recommend:

> "That the use of audio-visual aids in training centres should be extended and the development of teaching machines for the severely retarded should be more actively pursued by research workers in consultation with serving teachers." (1968, p.27),

which lends weight to the suggestion that a machine could have greater attractiveness than many conventional apparatus.

The dilemma that this poses could be resolved if a machine similar to the Touch Tutor were available which had similar advantages but which was not only cheaper than the Touch Tutor, but easier to equip with programme material, somewhat easier for children to use and even less likely to require technical attendance and knowledge. This brings us to consider alternative machines to the Touch Tutor.

(iii) Alternatives to the Touch Tutor

In Chapter 9 a brief experiment in the use of the Touch Tutor to teach simple words to S.S.N. children was described. These same children were, in the course of that experiment, given similar words to learn with the Touch Tutor presenting the words on a single panel (in fact the aluminium mask over the touch panels of the Touch Tutor was inverted and the three small response panels blanked off). It was found that children learned the same number of words under the 'matching to sample' format as under the 'simple' format in the experiment, which immediately raised the question of whether matching to sample was a necessary presentation technique for such teaching on the machine.

On the basis of this experiment an experimental machine was designed which presented single stimuli on a 9" x 9" perspex panel. The child's task was to push this panel inwards, thereby activating a switch, which set a cassette tape-recorder of conventional design in motion. This enabled the replay of a spoken message of any length, at the end of which a slide-projector inside the machine presented the next stimulus.

Studies with this machine (described in Beasley, 1973) were conducted with a group of 10 S.S.N. adults and a group of 11 S.S.N. children in a subnormality hospital and a group of 12 S.S.N. children from a day Special School in the community. In the first two studies a series of words from Gunzburg's 'Social Sight' vocabulary were presented while in the third study a series of pictures of zoo animals were portrayed. Each study indicated that some of the subjects had acquired the names of some of the stimuli portrayed on the machine after working for periods of some 10 minutes on the machine. It was also found in the first two studies that approximately half the subjects repeated the name of the stimulus after the machine had spoken it.

These results, although from largely exploratory studies, suggest that the machine offers similar advantages to the Touch Tutor in terms of what children may learn from it and, in being similar to the Touch Tutor, would probably be as 'attractive' to the children and 'as usable in the classroom' as that machine. Moreover, the design of the machine is somewhat more flexible than the Touch Tutor's: the single stimuli mean that the mounting of stimuli in the slide-holders need not be so exact (as was necessary in the Touch Tutor) and that programmes could be made from photographs taken with an ordinary camera (or 'write-on' slides could be used). The recording of the verbal commentary is also easier than in the case of the Touch Tutor, requiring no apparatus other than the tape-recorder and its microphone. Finally, the machine is less complex technically and hence both less likely to fail and less liable to need adjustment.

This machine would seem, then, to be offering similar advantages to the Touch Tutor. Since its cost would be in the region of £200 it would accordingly seem to represent a less costly alternative to the Touch Tutor. Its disadvantages relate mainly to whether it is considered necessary that the subject makes a choice on such machines which is detected by the machine. It could be argued that this machine actually teaches nothing, since the child is given no opportunity to make 'correct' responses and to receive reinforcement for them.

The most satisfactory answer to such a criticism would be empirical information about whether children do learn as well under conditions of 'single' presentation as under conditions of 'matching to sample' presentation in which correct choices are rewarded. It is, however, illuminating to remember that demonstrations have been made of the occurrence of learning under conditions in which active responding did not take place (as in, for example, the various 'latent learning' experiments), in conditions in which responding took place but was directed at other features ('incidental learning') and in which learning occurred without obvious reinforcement (for example, 'exploratory behaviour'). Moreover, the various demonstrations of 'errorless learning' under conditions of carefully programmed stimuli show that incorrect responses are not necessary for learning to take place. It is possible that children could learn quite well under conditions of single presentation of stimuli (as indeed normal children do from being read stories, from looking at picture books and from looking at the television). It might even be possible to encroach on the particular domain of matching to sample and use a single presentation to teach discriminations.

To summarize, a machine employing 'single' presentation of material, but otherwise essentially similar to a machine like the Touch Tutor, cold clearly be as useful as such a machine in certain areas - thus, both machines would be potentially capable of presenting a planned teaching programme, of giving individual instruction, of enabling the teacher to be relieved from repetitious drill work and it might even prove to be capable of teaching discriminations. It would not give reinforcement which was clearly contingent upon correct responses in the usual sense, but it might anyway be argued that the Touch Tutor gives that only for the few children who respond to it completely correctly. The machine would probably be as attractive to the children as the Touch Tutor, would probably be usable by at least as many children as those responding to one-choice slides correctly on the Touch Tutor, would be probably at least as easy to use in the classrooms and would probably have greater practical potential for the development of further teaching programmes.

On this basis the present writer would argue that the Touch Tutor's design is unnecessarily expensive and that substantially similar educational advantages would be found in a cheaper machine employing a single presentation of stimulus material.

Whether one could devise even less expensive machines which would be suitable is difficult to say. One which springs immediately to mind is the Language Master, retailed at a cost of some £60 by the Bell and Howell Corporation. This is a small machine which can speak the name of a picture or word portrayed on a piece of card when this card is inserted in the machine. The card is carried through the machine across the child's field of vision as it 'speaks'. The machine appears to have had some encouraging results with young normal children learning to read, with backward readers and with immigrant pupils learning to read English. Little appears to have been done with S.S.N. pupils and the main drawback in its use with them would probably be the necessity for the pupil to insert his own cards in the machine continually, the rather 'ordinary' appearance of the stimulus material and the overall smallness and comparative fragility of the system.

Other machines could be envisaged which would, for example, require a matching response from the subject and give knowledge of results, with cards being inserted with the stimulus material on them. Gunzburg (1968) has used machines like this, although little seems to have been written about results obtained with them. However, it is likely that such machines would suffer from similar disadvantages as the Language Master. Such machines invariably will provide advantages in terms of cost at the expense of omitting the potentially valuable facilities of automated presentation of stimuli (requiring, most simply, a slide projector) and auditory feedback (necessarily requiring a tape recorder).

It is likely, therefore, that if a teaching machine is regarded as valuable for the S.S.N. pupil the minimum cost required to make a machine which would be more than a fairly simple 'gadget' would be in the region of £150 - £200 (allowing for the cost of materials, labour and for a small 'profit margin' to make production possible).

Finally, it must be noted that the clause: "if a teaching machine is regarded as valuable" is a crucial one. It has not been the purpose of the present work to argue that teaching machines like the Touch Tutor (or any other kind of teaching machine) are better than conventional apparatus. Rather, the work has aimed to provide a basis for deciding whether such machines are sufficiently suitable and worthwhile to have any place in the education of the S.S.N. child. It is questionable whether study need be aimed at deciding whether machines are 'better' than conventional techniques. Nevertheless, the present writer believes that such a question is unnecessary only when sufficient funds are available for the purchase of any new promising technique. If one has the aim of increasing the value of educational techniques to the S.S.N. child, and one has limited funds, study of the effectiveness of alternative techniques ought to be made. The writer believes that a start to this could be made by the simple expedient of measuring the numbers of children responding to various pieces of conventional apparatus, for how long they respond, and what they seem to learn from them. Such study might reveal some extremely vital facts about classroom teaching and expose some widely held but erroneous assumptions about the practical teaching of the S.S.N. child.

Appendix 1: Key to Column Numbers

Column Number	Description of Variable
1	Subject number
2	Subject's initials (children who took part in Experiment 2 only).
3	I.Q. * = Wechsler Intelligence Scale for Children ** = Stanford - Binet Intelligence Scale *** = Wechsler Pre-school and Primary Scale of Intelligence - = Record of testing, but no measure obtained.
4	Age at time of testing (nearest year)
5	Number of trials (sessions) in 'Exploratory' studies.
6	Pre-test: one-choice slides; correct/completed.
7	-do- three-choice slides; - do -
8	Total time (minutes) in Mobile Laboratory during all stages of Experiment 1.
9	Total slides completed unaided during ditto.
10	Response rate during ditto.
11	Post-test: one-choice slides; correct/completed.
12	-do- : two-choice slides: - do -
13	-do- : three-choice slides: - do -
14	-do- : nonsense shape slides: -do -

Appendix 1.

Details of Sample and Raw Data for Experiment 1 (Chapter 5)

Experimental Group: 'No Sound Mixed'.

1	J.H.	46*	17		10/10	3/10	38	184	4.84	10/10	6/10	7/10	4/10
2		56*	10		8/10	3/10	50	215	4.30	10/10	10/10	9/10	6/10
3	M.W.	46*	16		7/10	3/10	51	104	2.04	8/10	7/10	2/10	0/4
4		54**	9		9/10	4/10	42	350	8.33	10/10	4/10	4/10	1/10
5	A.E.	52**	11		9/10	4/10	46	263	5.72	10/10	7/10	4/10	4/10
6	S.H.		11		9/10	2/10	41	290	7.07	9/10	5/10	4/10	3/10
7	H.D.		15	2	10/10	5/10	45	183	4.07	10/10	6/10	3/10	2/5
8	M.K.		10	2	4/4	2/2	35	42	1.20	10/10	3/6	0/0	0/0
9			19		3/10	3/10	39	73	1.87	1/10	0/1	0/0	0/0
10			15	1	2/5	0/0	41	34	0.83	4/10	0/2	0/0	0/0
11			16		0/2	0/0	21	8	0.39	0/0	0/0	0/0	0/0
12			13		1/1	0/0	14	2	0.14	0/0	0/0	0/0	0/0
13			8		0/0	0/0	12	0	0.00	0/0	0/0	0/0	0/0
14			11		0/1	0/0	20	5	0.25	0/4	0/0	0/0	0/0

Experimental Group: 'No Sound Progressive'

15			13		8/10	3/10	43	59	1.34	0/3	0/0	0/0	0/0
16			15		6/10	3/10	43	160	3.72	6/10	5/10	5/10	5/10
17	J.B.		9		6/10	5/10	35	270	7.71	10/10	6/10	0/10	2/10
18		46*	13	2	10/10	9/10	55	296	5.38	10/10	9/10	8/10	7/10
19	S.E.		14	3	3/5	0/0	36	29	0.80	10/10	0/6	0/0	0/0
20			11	2	6/10	3/10	38	78	2.05	7/10	2/4	0/0	0/0
21			19	2	10/10	9/10	50	293	5.86	9/10	9/10	6/10	0/3
22		11**	18		9/10	0/0	40	181	4.52	5/5	0/0	0/0	0/0
23		41***	11	1	10/10	10/10	33	260	7.88	10/10	9/10	10/10	7/10
24	D.C.	31***	16		10/10	3/10	38	164	4.31	10/10	7/10	1/4	0/0
25	V.W.		12	2	10/10	5/10	46	218	4.74	10/10	6/10	3/10	2/10
26			7		3/6	0/0	26	11	0.45	1/4	0/0	0/0	0/0
27			9		0/0	0/0	13	0	0.00	0/0	0/0	0/0	0/0
28			14		2/2	0/0	17	8	0.47	1/1	0/0	0/0	0/0
1	2	3	4	5	6	7	8	9	10	11	12	13	14

(Column Numbers)

Experimental Group: 'Sound Mixed'.

29			17	1	10/10	9/10	37	200	5.40	10/10	7/10	10/10	8/10
30		50*	15	1	10/10	4/10	55	300	5.45	10/10	7/10	6/10	8/10
31	H.H.		17		5/10	6/10	76	191	2.51	9/10	6/10	5/10	4/10
32		60*	14	1	10/10	10/10	49	299	6.10	10/10	10/10	10/10	10/10
33		20***	9		6/10	2/4	49	80	1.63	4/10	2/10	1/10	3/10
34			15		0/0	0/0	28	9	0.32	2/9	0/0	0/0	0/0
35			13		1/2	0/0	30	31	1.03	1/10	0/4	0/0	0/0
36			11	3	1/3	0/0	6	3	0.50	0/0	0/0	0/0	0/0
37			13		1/4	0/2	24	9	0.38	0/0	0/0	0/0	0/0
38			10		0/0	0/0	13	1	0.08	0/1	0/0	0/0	0/0
39			11		0/1	0/2	18	9	0.50	3/3	0/0	0/0	0/0

Experimental Group: 'Sound Progressive'.

40		46**	16		10/10	5/10	47	290	6.17	10/10	5/10	5/10	10/10
41		-*	15	2	10/10	6/10	56	319	5.70	10/10	10/10	10/10	6/10
42			13		2/10	1/6	40	186	4.65	5/10	5/10	6/10	3/10
43			12	2	8/10	8/10	49	210	4.28	10/10	6/10	8/10	9/10
44		-*	13	2	10/10	8/10	10	60	6.00	0/0	0/0	0/0	0/0
45	D.P.		13		3/4	0/0	39	148	3.79	9/10	3/10	5/10	3/10
46	P.D.		14		7/10	3/10	51	260	5.10	10/10	7/10	3/10	4/10
47			11		9/10	1/10	16	56	3.50	0/0	0/0	0/0	0/0
48	M.J.		12		10/10	5/10	54	213	3.94	8/10	7/10	7/10	3/10
49			9		4/4	0/0	18	16	0.90	4/6	0/0	0/0	0/0
50			8		3/7	0/0	21	14	0.67	0/0	0/0	0/0	0/0
51			13		0/0	0/0	16	0	0.00	0/0	0/0	0/0	0/0
52			12		0/0	0/0	14	0	0.00	0/0	0/0	0/0	0/0
1	2	3	4	5	6	7	8	9	10	11	12	13	14

(Column Numbers)

Appendix 2: (Key to Column Numbers)

Column Number	Description of Variable
Experiment 2 (Stallington)	
1	Subject's initials.
2	Subject's age(nearest year) at time of testing.
3	I.Q. (see Appendix 1).
4,7,10,13,16	Time (seconds) to complete 36 two-choice slides unaided during Sessions 1 to 5.
5,8,11,14,17	Response rates (slides completed per minute) during this time.
6,9,12,15,18	Number of slides completed correctly during Sessions 1 to 5.
Experiment 3 (Redcourt)	
1	Subject's number.
2	Subject's initials (Children responding during Experiment 3 only).
3	Subject's age (nearest year) at time of testing.
4,7	Slides 11-20 (one-choice); correct/completed.
5,8	Slides 21-30 (two-choice); -do-
6,9	Slides 47-56 (two-choice); -do- during Sessions 1 and 2.
10,11	Slides 21-36 (two-choice); correct/completed during Sessions 1 and 2.
12,14	Slides 11-20 (one-choice); time(seconds) to complete during Sessions 1 and 2.
13,15	Slides 21-36 (two-choice); time (seconds) to complete during Sessions 1 and 2.

Appendix 2

Details of samples and raw data for Experiments 2 and 3 (Chapter 6); slides (programme materials) used in those Experiments.

Experiment 2

One-choice Instruction

M.W.	16	46	257	8.40	19	253	8.54	19	254	8.50	18	260	8.31	18	258	8.37	18
J.B.	11		286	7.50	20	298	7.25	24	292	7.40	32	287	7.53	26	300	7.20	31
V.W.	13		372	5.81	26	323	6.69	29	342	6.31	26	337	6.41	35	353	6.12	35
P.D.	14		304	7.11	19	301	7.18	18	305	7.08	33	317	6.81	35	315	6.86	35
J.H.	19	46	373	5.79	29	495	4.36	26	425	5.08	33	327	6.60	29	320	6.75	30
H.H.	18		577	3.74	20	595	3.63	18	451	4.80	20	391	5.52	14	-	-	-
S.E.	14																

Two-choice Instruction

A.E.	11	52	329	6.56	34	277	7.80	33	451	4.79	30	280	7.71	33	282	7.66	35
S.H.	11		276	7.83	18	274	7.88	7	293	7.37	22	-	-	-	-	-	-
M.J.	13		358	6.03	17	-	-	-	-	-	-	-	-	-	-	-	-
H.D.	16		305	7.08	14	312	6.92	20	313	6.90	15	300	7.20	17	324	6.67	20
D.P.	13		252	8.57	18	324	6.67	20	302	7.15	14	270	8.00	19	263	8.21	18
M.K.	11		272	7.94	18	263	8.21	17	276	7.83	18	364	5.93	18	272	7.94	18
D.C.	17	31	256	8.43	36	257	8.40	36	255	8.47	36	262	8.24	36	261	8.27	36

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

(Column Numbers)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Experiment 3

1	H.S.	12	8/8	9/10	7/10	-	-	-	31/36	-	106	535	-	-
2	R.C.	13	8/10	5/10	8/10	10/10	8/10	9/10	27/36	30/36	290	456	140	345
3	S.G.	14	9/10	5/10	4/10	10/10	6/10	5/10	19/36	22/36	85	286	90	312
4	M.W.	12	8/8	7/10	5/10	10/10	4/10	5/10	21/36	19/36	195	319	168	327
5	A.R.	13	7/7	4/10	4/10	10/10	9/10	7/10	21/36	32/36	345	630	146	401
6	P.J.	11	9/10	4/10	5/10	10/10	7/10	7/10	15/36	25/36	83	260	142	247
7	R.W.	12	6/10	5/10	5/10	10/10	4/10	5/10	20/36	16/36	133	306	100	287
8	B.W.	14	10/10	6/10	5/10	10/10	2/10	5/10	18/36	16/36	79	267	79	302
9	C.B.	10	10/10	6/10	5/10	10/10	6/10	7/10	18/36	19/36	73	273	76	351
10	A.G.	16	9/10	7/10	5/10	10/10	7/10	5/10	19/36	19/36	80	393	77	338
11	R.F.	13	10/10	5/10	0/0	10/10	6/10	6/10	12/22	18/36	96	476	92	347
12	C.L.	6	2/10	2/10	0/0	10/10	10/10	10/10	7/19	26/36	113	383	100	310
13	S.B.	13	10/10	5/10	0/0	10/10	3/10	4/10	9/16	18/36	183	305	161	344

14	C.M.	12	10/10	6/10	4/10	10/10	6/10	5/10	21/36	24/36	90	405	134	394
15		10	0/0			0/0			0/0	0/0				
16		14	0/0			0/0			0/0	0/0				
17		8	0/0			0/0			0/0	0/0				
18		10	0/0			0/0			0/0	0/0				
19		10	0/0			0/0			0/0	0/0				
20		9	0/0			0/0,			0/0	0/0				
21	V.T.	11	7/10	5/10	0/0	6/10	0/0	0/0	0/10	0/0	150	305	170	-
22		9	0/0			0/0			0/0	0/0				
23		8	0/0			0/0			0/0	0/0				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

(Column Numbers)

Slides used in Experiments 2, 2a and 3

Introductory (Demonstration) Slides

	One-choice		Two-choice	
	L. Panel	R. panel	L. panel	R. panel
1	man		man	clock
2		car	hand	car
3	clock		clock	house
4	car		car	chair
5		man	chair	man
6		house	man	house
7		hand	clock	hand
8	chair		chair	house
9	house		house	man
10	man		man	chair
11		car	house	car
12		hand	man	hand
13	clock		clock	car
14		man	hand	man
15	house		house	car
16		chair	car	chair
17		hand	man	hand
18		clock	car	clock
19	car		car	hand
20	chair		chair	clock

Programme Slides

Two-choice

	L.panel	R. panel		L.panel	R.panel
1	clock	car	19	clock	house
2	chair	house	20	car	chair
3	man	car	21	house	hand
4	hand	house	22	car	man
5	man	chair	23	house	hand
6	clock	car	24	clock	chair
7	hand	chair	25	hand	man
8	car	house	26	house	clock
9	hand	chair	27	man	car
10	house	hand	28	house	clock
11	chair	clock	29	chair	man
12	car	house	30	hand	clock
13	clock	man	31	car	man
14	man	car	32	chair	hand
15	clock	hand	33	car	house
16	chair	car	34	hand	clock
17	clock	man	35	chair	house
18	chair	hand	36	man	clock

The stimuli underlined in the above Table were those designated 'correct'.

Appendix 3: Key to Column Numbers

Experiment 2 (Stallington)

Column Number	Description of Variable
1	Subject's initials.
2,8,14,20,26	TB Correct responses, Sessions 1 to 5
3,9,15,21,27	TB Incorrect -do- , -do-
4,10,16,22,28	BT Correct responses, Sessions 1 to 5
5,11,17,23,29	BT Incorrect -do- , -do-
6,12,18,24,30	B..T Correct responses, Sessions 1 to 5
7,13,19,25,31	B..T Incorrect -do- , -do-

Experiment 3 (Redcourt)

1	Subject's initials.
2,8	TB Correct responses, Sessions 1 and 2
3,9	TB Incorrect responses, -do-
4,10	BT Correct responses, -do-
5,11	BT Incorrect responses, -do-
6,12	B..T Correct responses, -do-
7,13	B..T Incorrect responses, -do-

Experiment 2 (Stallington)

1	Subject's initials
2,12,22,32,42	'S'responees(Correct), Sessions 1 to 5
3,13,23,33,43	'S'Incorrect responses, -do-
4,14,24,34,44	'E'Correct responses, -do-
5,15,25,35,45	'E' Incorrect responses, -do-
6,16,26,36,46	'PE'Correct responses, -do-
7,17,27,37,47	'PE'Incorrect responses, -do-
8,18,28,38,48	'C' Correct responses -do-
9,19,29,39,49	'C' Incorrect responses -do-
10,20,30,40,50	'O' Correct responses -do-
11,21,31,41,51	'O' Incorrect responses -do-

Key to Appendix 3 (continued)

Experiment 3 (Redcourt)

Column Number	Description of Variable
1	Subject's initials.
2,12	'S' Correct responses, Sessions 1 and 2
3,13	'S' Incorrect responses -do-
4,14	'E' Correct responses -do-
5,15	'E' Incorrect responses -do-
6,16	'PE' Correct responses -do-
7,17	'PE' Incorrect responses -do-
8,18	'C' Correct responses -do-
9,19	'C' Incorrect responses -do-
10,20	'O' Correct responses -do-
11,21	'O' Incorrect responses -do-

Experiment 2a (Flaxley)

1	Subject's number
2	TB Correct responses
3	TB Incorrect responses
4	BT Correct responses
5	BT Incorrect responses
6	'S' Correct responses
7	'S' Incorrect responses
8	'E' Correct responses
9	'E' Incorrect responses
10	'PE' Correct responses
11	'PE' Incorrect responses
12	'C' Correct responses
13	'C' Incorrect responses
14	'O' Correct responses
15	'O' Incorrect responses
16	Total Correct during 36 slides
17	'Triangular' responses (at least one response to Top, Left and Right panels on a slide).
18	Habit scores (and number of Habit runs).

Appendix 3

Transcribed data from videotape recordings of response patterns (Chapter 7); Stallington and Redcourt samples.

(Column Numbers)

Experiment 2 (Stallington). Top responses of three kinds (with associated Correct and Incorrect responses).

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
M.W.	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	2	0	0	0	3	0	1
J.B.	4	4	1	4	1	1	3	1	4	4	0	6	4	0	7	4	1	0	7	2	10	6	0	1	3	0	24	1	1	4
V.W.	23	7	3	2	0	1	28	6	1	1	0	0	26	9	0	1	0	0	35	1	0	0	0	0	35	1	0	0	0	0
P.D.	2	1	5	9	2	4	7	1	10	13	0	4	19	0	13	3	0	0	12	0	23	1	0	0	35	1	0	0	0	0
J.H.	17	0	11	36	0	1	13	2	6	7	0	0	25	0	8	3	0	0	24	0	2	3	0	2	22	0	5	3	0	1
H.H.	11	9	1	2	0	0	13	7	0	0	0	0	14	11	2	2	0	2	10	17	1	2	0	1	-	-	-	-	-	-
A.E.	31	1	2	1	0	0	29	0	4	3	0	0	29	3	1	3	0	0	33	3	0	0	0	0	36	0	0	0	0	0
S.H.	2	4	4	4	11	9	0	0	13	15	2	3	2	0	20	2	0	12	-	--	-	-	-	-	-	-	-	-	-	-
M.J.	4	0	7	0	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H.D.	2	3	4	6	1	2	5	3	3	4	4	3	5	2	3	4	2	2	-	Data Lost (Video. fault)								-	-	-
D.P.	0	0	3	4	0	0	2	2	3	1	1	4	0	2	1	4	0	3	-	Data Lost (Video. fault)								-	-	-
M.K.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D.C.	36	0	0	0	0	0	36	0	0	0	0	0	36	0	0	0	0	0	36	0	0	0	0	0	36	0	0	0	0	0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

(Column Numbers)

Experiment 3 (Redcourt): Top responses of three kinds (with associated Correct and Incorrect responses)

H.S.	31	1	0	2	0	1	-	-	-	-	-	-
R.C.	27	6	0	3	0	0	29	2	1	4	0	0
S.G.	3	4	5	3	5	1	6	2	7	1	6	7
M.W.	8	5	5	4	4	3	12	13	0	1	1	0
A.R.	19	15	1	1	0	3	31	2	1	2	0	0
P.J.	3	1	1	2	1	5	18	2	5	6	0	3
R.W.	1	0	1	5	2	3	1	0	1	5	2	3
B.W.	0	0	0	0	0	0	15	16	0	3	0	0
C.B.	0	0	18	16	0	2	1	0	18	15	0	2
A.G.	19	15	0	2	0	0	18	17	1	0	0	0
R.F.	2	2	2	3	0	1	3	4	10	12	5	2
C.L.	0	2	1	3	0	0	35	0	1	0	0	0
S.B.	4	0	0	1	0	0	1	1	4	3	2	0
C.M.	4	1	16	17	1	1	5	1	15	7	1	1
1	2	3	4	5	6	7	8	9	10	11	12	13

(Column Numbers)

Appendix 3 (continued)

Experiment 2 (Stallington): Subsequent responses of five kinds (with associated Correct and Incorrect responses)

M.W.	0	0	11	15	4	3	9	0	0	0	0	0	18	18	0	0	0	0	0	0	0	1	0	14	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0
J.B.	1	0	4	15	0	0	9	0	1	0	1	1	1	9	0	0	0	0	1	1	2	0	4	4	0	0	1	0	0	0	1	2	4	8	0	0	1	0	0	0
V.W.	10	12	0	0	0	0	0	0	0	0	8	6	0	0	0	0	0	2	0	0	4	8	0	1	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	1
P.D.	6	1	1	14	0	0	0	0	1	2	1	0	0	18	0	0	3	0	0	0	1	0	0	3	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0
J.H.	1	0	1	7	0	0	2	0	2	0	1	1	3	8	0	0	0	0	0	0	2	3	6	0	0	0	0	0	0	0	0	2	2	3	0	0	0	0	0	0
H.H.	2	4	3	0	0	0	1	0	0	4	0	7	0	2	0	0	0	0	0	0	3	4	1	4	0	0	0	1	0	0	5	12	0	0	0	0	0	2	3	3
A.E.	1	0	0	0	0	0	0	0	0	1	2	0	1	3	0	0	0	4	0	0	1	5	1	3	0	0	2	0	0	0	1	0	0	3	0	0	0	0	0	0
S.H.	13	8	0	1	0	0	2	2	1	8	3	14	0	1	0	0	1	0	0	2	0	4	0	4	0	0	0	0	0	5	-	-	-	-	-	-	-	-	-	-
M.J.	0	0	5	4	1	13	2	2	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H.D.	0	0	2	2	11	16	0	0	0	0	2	1	10	6	7	5	2	1	0,	0	5	1	5	17	0	0	0	0	5	3	-	Data lost			-	-	-	-	-	-
D.P.	0	1	10	2	8	12	0	0	0	0	1	0	5	12	5	5	0	0	0	0	3	4	2	12	0	0	1	2	1	1	-	Data lost			-	-	-	-	-	-
M.K.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
D.C.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41

(column Numbers)

Experiment 2 (Stallington): Subsequent responses ... (continued)

	42	43	44	45	46	47	48	49	50	51
M.W.	0	0	0	18	0	0	0	0	0	0
J.B.	0	4	2	1	0	0	5	0	0	0
V.W.	4	0	0	0	0	0	0	0	0	0
P.D.	0	0	0	0	0	0	6	0	0	0
J.H.	2	4	0	1	0	0	1	0	0	0
H.H.	-	-	-	-	-	-	-	-	-	-
A.E.	0	0	1	0	0	0	0	0	0	0
S.H.	-	-	-	-	-	-	-	-	-	-
M.J.	-	-	-	-	-	-	-	-	-	-
H.D.	3	3	0	3	0	0	4	3	3	3
D.P.	1	1	8	11	6	6	0	0	0	0
M.K.	0	0	0	0	0	0	0	1	0	0
D.C.	0	0	0	0	0	0	0	0	0	0

(Column Numbers)

Experiment 3 (Redcourt): Subsequent responses (with associated Correct and Incorrect responses) of five kinds.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
H.S.	1	1	0	0	0	0	1	1	0	0	-	-	-	-	-	-	-	-	-	-
R.C.	27	9	0	0	0	0	0	0	0	0	28	4	4	0	0	0	0	0	0	0
S.G.	12	3	2	5	0	0	0	0	5	8	14	6	3	1	0	0	0	0	3	2
M.W.	15	11	2	3	0	0	0	0	1	1	4	8	1	2	0	0	1	0	1	2
A.R.	4	9	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0
P.J.	5	10	1	2	0	0	2	0	2	7	5	5	2	4	0	0	2	0	0	2
R.W.	4	5	5	5	5	0	0	0	2	4	2	2	7	11	1	2	2	1	0	4
B.W.	0	8	0	1	0	0	0	1	0	1	0	12	0	1	0	0	0	2	0	1
C.B.	12	11	2	2	0	0	0	0	1	2	17	16	0	1	0	0	0	0	2	0
A.G.	4	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0
R.F.	1	2	1	2	0	0	1	0	0	1	15	16	0	1	0	0	0	0	0	1
C.L.	1	2	0	1	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0
S.B.	1	0	1	2	1	0	0	0	2	0	4	0	7	10	2	3	0	0	1	0
C.M.	15	8	1	2	0	0	2	2	1	1	16	7	1	4	0	0	3	0	3	0

(Column Numbers)

Appendix 3 (continued)

Experiment 2a (Flaxley): Top and Subsequent responses (with associated Correct and Incorrect responses), Total Correct responses, 'Triangular' responses and Responses to lower panels of machine (Habit Scores)

One-choice Instruction

1	36	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	M31(1)
2	35	1	0	0	0	0	0	0	0	0	1	1	0	0	35	0	M30(1)
3	34	2	0	0	0	1	0	0	0	0	0	0	1	0	34	0	M24(1)
4	35	1	0	0	0	0	0	0	0	0	0	0	0	0	35	0	M25(2)
5	35	1	0	0	0	1	0	0	0	0	0	0	0	0	35	0	M28(2)
6	33	0	2	1	1	1	0	0	0	0	0	0	0	0	35	2	M29(1)
7	34	1	0	0	0	1	0	0	0	0	0	0	0	0	34	0	M24(1)
8	28	1	7	0	0	1	2	0	0	0	0	0	0	0	35	0	M26(1)
9	18	18	0	0	0	0	0	0	0	0	0	2	0	0	18	0	PP30(1)
10	0	0	0	0	0	0	0	0	18	18	0	0	0	0	18	0	PP30(1)
11	0	1	18	17	14	2	1	11	0	0	0	0	3	3	18	33	PP30(1)
12	18	18	0	0	0	0	0	0	0	0	0	0	0	2	18	2	PP15(3)
13	1	0	17	18	18	18	0	0	0	0	0	0	0	0	18	36	PP30(1)
14	4	5	12	14	17	17	0	0	0	0	0	0	0	0	17	34	PP 4(2)

Two-choice Instruction

15	36	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	M31(1)
16	36	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	M31(1)
17	34	1	1	0	0	0	0	0	0	0	0	0	0	0	36	0	M31(1)
18	36	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	M31(1)
19	36	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	M31(1)
20	34	2	0	0	0	0	0	0	0	0	0	0	0	0	34	0	M21(2)
21	35	1	0	0	0	0	0	0	0	0	0	0	0	0	35	0	M26(1)
22	28	8	0	0	0	0	0	0	0	0	0	0	0	0	28	0	M 2(2)
23	22	14	0	0	22	14	0	0	0	0	0	0	0	0	22	36	M 6(1)
24	18	18	0	0	0	0	0	0	0	0	0	0	0	0	18	0	PA 24(1)
25	20	16	0	0	2	16	0	0	0	0	0	0	0	0	20	11	W19(1)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

(Column Numbers)

Appendix 4: Key to Column Numbers

Column Number	Description of Variable
1	Subject's number
2	Time (minutes) spent at machine
3	Number slides completed
4	% slides correct
5	Response rate.
6	Post-test; 20 one-choice slides; correct/completed.
7	Post-test; 20 three-choice slides; correct/completed.

Columns 6 and 7 show Post-test data for '-2' slides only; the data obtained with the black ahd white slides were essentially identical.

Appendix 4

Raw data for Experiment 4.

1	15	120	100	8.0	10/10	10/10
2	24	131	81	5.4	10/10	10/10
3	15	59	66	3.9	10/10	6/10
4	17	193	100	8.0	10/10	7/10
5	12	58	72	4.8	10/10	10/10
6	7	44	84	6.3	10/10	6/10
7	15	58	78	3.9	10/10	6/10
8	16	6	67	0.4	10/10	10/10
9	57	54	100	0.9	10/10	10/10
10	14	78	100	5.6	10/10	9/10
11	31	128	77	4.1	10/10	10/10
12	35	212	98	6.1	10/10	6/10
13	36	139	76	3.9	10/10	6/10
14	6	31	77	5.2	10/10	6/10
15	17	56	62	3.3	10/10	7/10
16	15	68	65	4.5	-	-
17	34	158	82	4.6	0/0	0/0
18	10	34	97	3.4	10/10	10/10
19	7	23	96	3.3	0/0	0/0
20	18	112	100	6.1	0/10	0/10
21	5	22	32	4.4	-	-
22	5	0	0	0.6	0/0	0/0
23	5	0	0	0.0	0/0	0/0
24	20	39	67	2.0	10/10	5/10
25	10	29	45	2.9	10/10	6/10
26	11	62	55	5.6	10/10	6/10
1	2	3	4	5	6	7

(Column Numbers)

Appendix 5: Key to Column Numbers

Column Number	
1	Subject's initials.
2,5, 8 etc.	Session time in minutes and decimal parts of a minute, Sessions 1 - 20.
3,6, 9 etc.	Total no. sorting responses per session(cards actually placed in box)/no. cards actually completed.
4,7,10 etc.	No. correct first attempts per session/ no. correct in subsequent attempts (up to limit of six).
62	Age of S. to nearest year.
63	S-B I.Q. July 1972. NT = not tested UT = no responses to any S-B item.

Appendix 5

Raw data for Experiment 5.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A.W.	3.65	36/36	36/0	3.55	36/36	36/0	3.60	38/36	34/2	3.30	37/36	35/1	4.33	36/36	36/0	3.70	36/36	36/0
K.B.	6.93	36/36	36/0	6.75	39/36	33/3	6.70	40/36	32/4	6.35	40/36	32/4	6.60	37/36	35/1	6.22	38/36	34/2
C.N.	1.75	36/36	36/0	1.75	36/36	36/0	1.15	37/36	35/1	1.33	36/36	36/0	1.15	36/36	36/0	1.10	36/36	36/0
C.H.	10.00	8/1	0/0	12.00	22/10	7/2	11.90	37/36	35/1	9.10	36/36	36/0	10.45	39/36	33/3	6.85	36/36	36/0
L.P.	14.00	38/9	3/1	10.00	40/13	6/3	11.00	28/6	1/1	11.60	29/6	0/2	10.30	25/6	1/2	9.80	29/7	1/3
M.M.	10.00	6/1	0/1	10.00	4/1	0/1	10.00	0/0	0/0	10.50	20/4	0/1	9.60	17/6	3/1	11.20	9/2	0/1
M.D.	8.00	4/1	1/0	5.00	7/3	2/0	8.50	14/3	0/1	6.20	9/1	0/0	8.00	7/3	1/1	2.00	3/0	0/0
T.J.	10.50	34/7	1/4	10.00	30/6	0/3	8.75	25/7	2/1	11.30	33/7	1/1	10.20	19/6	3/1	10.50	27/7	2/4
J.M.	3.00	1/1	1/0	10.60	4/1	0/0	5.35	4/1	0/1	8.40	7/1	0/0	10.00	9/2	1/1	10.10	12/2	0/0
P.W.	10.00	0/0	0/0	No change throughout experiment........														

(Column Numbers)

	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
A.W.	4.15	39/36	34/2	4.85	44/36	28/8	4.35	37/36	35/1	4.30	37/36	35/1	4.40	40/36	32/4	4.67	37/36	35/1
K.B.	7.60	38/36	34/2	5.74	37/36	35/1	5.17	37/36	35/1	5.72	39/36	33/3	6.90	37/36	35/1	5.85	36/36	36/0
C.N.	1.30	36/36	36/0	1.15	36/36	36/0	Discontinued.											
C.H.	6.50	36/36	36/0	Discontinued.														
L.P.	9.80	19/7	3/2	10.40	27/8	2/4	10.10	19/7	2/5	10.00	11/2	0/0	5.00	8/2	0/1	9.20	21/4	0/2
M.M.	11.00	15/4	1/1	10.00	2/0	0/1	9.50	10/3	0/2	9.60	9/2	0/1	9.70	11/2	0/1	10.60	14/3	0/1
M.D.	3.00	3/0	0/0	Discontinued.														
T.J.	9.90	23/5	0/2	11.65	38/7	1/0	10.70	25/5	1/1	9.70	25/5	1/0	10.60	30/7	0/4	10.00	33/8	1/5
J.M.	9.90	6/1	0/0	10.60	9/2	0/1	9.90	6/1	0/0	9.20	7/2	0/2	10.00	1/0	0/0	10.00*	6/1	0/0
P.W.	....																	

	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
A.W.	4.70	38/36	34/2	3.45	36/36	36/0	3.51	37/36	35/1	4.35	36/36	36/0	4.65	38/36	34/2	4.20	36/36	36/0
K.B.	5.22	38/36	34/2	6.00	36/36	36/0	5.30	36/36	36/0	5.45	36/36	36/0	5.20	37/36	35/1	5.10	36/36	36/0
L.P.	9.40	15/2	0/0	9.80	18/3	0/2	10.10	28/6	1/1	7.00	17/6	3/2	7.00	17/3	0/1	9.00	21/5	1/1
M.M.	10.30	10/3	1/0	10.00	9/2	0/1	10.35	19/5	1/2	10.20	20/5	2/0	10.10	19/5	1/1	10.20	22/5	1/1
T.J.	9.60	29/10	3/4	10.00	16/5	2/2	9.80	21/5	1/2	9.60	25/6	2/1	10.21	25/8	4/3	10.00	36/9	1/7
J.M.	10.00	3/0	0/0	10.00	2/0	0/0	10.00	9/2	0/0	10.00	1/0	0/0	10.00	1/0	0/0	10.00	3/0	0/1
P.W.	....																	

*Smarties begun.

Appendix 5 (continued)

A.W.	3.90	36/36	36/0	3.95	37/36	35/1	12	37
K.B.	5.25	36/36	36/0	5.60	36/36	36/0	13	23
C.N.							15	NT
C.H.							17	Less than 15
L.P.	8.20	20/4	0/1	10.00	24/5	1/1	10	Less than 20
M.M.	10.10	20/4	0/1	9.50	16/5	1/1	14	NT
M.D.							16	UT
T.J.	10.10	34/8	3/6	9.83	32/7	2/5	15	NT
J.M.	10.00	4/0	0/0	10.00	7/2	0/1	11	UT
P.W.	....	....	....	....	....	....	14	NT
	56	57	58	59	60	61	62	63

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