TREATING THE PERCEPTUAL - MOTOR PROBLEMS OF ADULT MALES

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ABSTRACT

Articles regarding perceptual-motor deficiencies of adults are beginning to be published in the literature (Saunders and Barker, 1972). It seems that, even though many children are now being treated for this disorder at or before school-going age, many people had perceptual-motor problems years ago when there was no knowledge of the disorder or its treatment. More than likely, as children, these people were considered to be simply low in intelligence.

Now, however, those children have grown up and, with the information we have, it is possible to ascertain from their symptoms, even as adults, that perceptual-motor problems exist. Once it can be established that such difficulties exist. measures can be taken to alleviate them.

Saunders and Barker (1972) used a remedial reading technique to help their subjects learn to read, and psychotropic drugs to help them over their emotional problems related to the perceptual dysfunction. The drugs helped the adults, the remedial reading programme did not.

This present study was concerned with improving perceptual-motor deficiencies in adults using a behaviour modification approach. A large sample of adult subjects was available in the population of Malawian males, novices to the mining industry, who were to undergo a three-week training programme in preparation for work underground. Perceptual-motor testing and discussions with the mine personnel assured the author that most of these subjects did suffer from perceptual-motor problems.

All were tested prior to training on the Classification Test Battery (1971), a perceptual test used by the mining industry to classify labourers according to their adaptability to training for various occupations. The control group was then trained in the standard manner laid down by the mining company, involving mostly the learning of the lingua franca of the

mines, Fanakalo, by imitation, the use of tools and safety lectures.

The experimental group was trained using operant techniques. The subjects were reinforced for many behaviours which would increase their perceptual and motor abilities. The subjects engaged in a great many exercises and games, plus perceptual-motor training that involved matching audition and vision to motor movements. It was theorised that by increasing their abilities in these areas they would have better organised perceptual information with which to learn the new behaviours necessary for work in a gold mine. The hypothesis was that these subjects would reach the target behaviours quicker and more easily than the control group.

The target behaviours, specific to the mining industry, were for the subjects to speak Fanakalo well enough to understand instructions and ask questions, to use the tools necessary for the job as they are meant to be used, to perform their job well from the start, and to avoid injuring themselves.

The shortcomings of this study were in the methods used for the evaluation of the outcome. When the subjects were re-tested on the Classification Test Battery no significant difference was found between groups. It has since been discovered that this was a poor choice of test.

Another evaluation technique, a checklist drawn up by the author, gave an indication of significant improvement in the experimental group. However, the checklist was only applied to 17½ per cent of each population. It was originally intended only as a check on the results given by the Classification Test Battery. A definite conclusion, therefore, cannot be drawn on that small amount of information.

The information obtained from the checklist does, however, point to the fact that the operant techniques used could be expected to improve the perceptual-motor behaviours of the subjects. There is evidence which

allows one to expect that this procedure, carried out on a larger scale and evaluated completely, will give positive results useful to the mining industry as well as to those adults who suffer from perceptual-motor dysfunctions.

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1 INTRODUCTION

This study was concerned with improving the perceptual-motor abilities of adult male labourers in the mining industry. This was attempted by integrating a programme of physical and perceptual exercises into an already existing training programme for the development of the skills necessary for work underground. The experimental group received extra perceptual-motor training, while the control group received the normal training given by the mine.

The definitions of the problems were arrived at through discussions with both the mining personnel in charge of the subjects' training and subsequent work situations. In short, the problems included a slowness in learning Fanakalo, in learning to understand orders, in learning to handle the necessary tools, and a propensity for injury on the job. The target behaviours of this study were to alleviate these problems through perceptual-motor training. The physical and perceptual training was given so as to organise their perceptual abilities more fully.

The reasons for using motoric means for perceptual learning are dealt with in full in the theoretical sections of this study. In order to test the efficacy of these procedures, two evaluation methods were used. The subjects were divided into control and experimental groups of one hundred subjects each. Both groups were tested before and after their respective training sessions on the Classification Test Battery (CTB). In addition, the underground work behaviours of the two groups were sampled. A checklist was devised by the author and administered to the shiftbosses in charge of the individual subjects. The shiftbosses rated the subjects on their abilities to attain the target behaviours of this study in their work underground.

The results of the study were, unfortunately, not conclusive. On the CTB both groups improved their scores by a statistically similar amount. However, the degree of improvement seems not to have been related to training, but rather to experience with the test.

Versver (1974) has shown that subjects being re-tested on the CTB continue to show improvement, simply due to test experience, until they have taken the test four to five times. This research is recent and was not known at the time this study was being carried out.

Had the author been forearmed with this information, it would have been possible to test the subjects every morning of the first five days of their training programme, until they had reached their peak. Then the post-test could have been expected to give useful information. The experimental group would have been expected to show a still higher score after, say, the sixth trial, whereas the control group would have been expected to show little or no further improvement after the sixth trial.

The results of the checklist, although inconclusive because of the smallness of the sample, point to a marked improvement in the experimental group. The shiftbosses, who were well acquainted with the work abilities of the individual subjects, but who knew nothing of the additional training, rated those subjects who were in the experimental group higher than those in the control group on such items as ability to speak Fanakalo, knowledge of the tools necessary for work, and numbers of days absent from work.

However, since this checklist was meant to be merely a check on the CTB, only a sample of the populations was rated. It had been expected that the results of the CTB would show a significant improvement by the experimental group, so that the checklist would be necessary only to confirm the improvement in a random sample of the two populations.

It was, however, the checklist which was the most sensitive instrument and which showed the improved perceptual-motor activities in the experimental group. The checklist should have been administered to all the shiftbosses involved with all the subjects in the two groups in the study. This was a misjudgment by the author.

In general, errors in choosing and carrying out the evaluation procedures made for the most serious shortcomings in this study. Only on a limited amount of information can it be said that the experimental subjects of this study showed some improvement. However, the degree of improvement shown by those subjects rated was impressive. The experimental subjects who were followed through training to the work environment seemed to have reached the target behaviours quickly and easily compared with the control subjects.

On the basis of this information it would seem that this experimental procedure, namely perceptual-motor behaviour modification for adults, deserves further investigation. A replication of the procedure, possibly on a larger scale, may show a statistical difference between groups if an evaluation technique such as the checklist were administered to the entire population.

The procedure itself is simple and easy to adapt to the needs of individual subjects. It is, in addition, more interesting for the subjects themselves. The subjects in this experimental group did not become as listless and bored during Fanakalo training as did those in the control group, because they were reinforced with an activity they enjoyed after their Fanakalo classes. That activity, the exercises, also gave them the necessary physical experience with which to orient their perceptions, as well as giving them the strength necessary for work underground.

This procedure could easily be put into effect on a larger scale to determine its effectiveness more precisely. The evidence gained in this study does point to the fact that the experimental procedure can be expected to show positive results for the labourers and the industry.

This procedure could be expected to work as well for any group of adults whose environment did not allow them to develop adequate perceptual-motor skills. Of course, it would be best to rectify the problems in childhood, as is being done in the white community more and more. Such perceptual-motor training could easily be carried out with black children, as well, in their school programmes. This study shows that the same procedures are equally effective for adults who have had deficient perceptual-motor training in their early days.

2 PERCEPTUAL-MOTOR PROBLEMS OF ADULTS

Little research has been done to date which deals with the perceptual-motor deficiencies of adults. Therapists have only been able to treat the problem which is ancillary to the perceptual-motor dysfunction in adults, for example, depression (Saunders and Barker, 1972). However, children's perceptual-motor difficulties have been dealt with in depth (Bender, 1956; Frostig, 1970; Johnson and Myklebust, 1967; Kephart, 1971; Oxendine, 1968). These workers have done a great deal to help in the amelioration of these problems in children. The purpose of this study is to apply a selected training programme based on the research with children to a group of adults with perceptual-motor problems.

With the increasing amount of literature focusing on these problems in adults (World Federation of Neurology, 1968), especially their inability to read, it has become evident that some research is necessary into ways of helping perceptually deficient adults gain in their perceptual functioning. One method of improving these deficiencies was attempted in this study.

2.1 The Aim of the Study

The hypothesis of the study was that operant behaviour modification procedures would improve the perceptual-motor abilities of a group of adults, in this case African mine labourers. A group of Malawian mine workers was tested, prior to carrying out the experiment proper, and all were found t show signs of perceptual difficulties, to some extent, on a variation of the Kohs' Blocks Test. All labourers have a short training period before beginning work underground. Therefore, it was possible to adapt that time to the present purposes, so that the subjects could learn the necessary material for work, using behavioural methods which would, hypothetically, alleviate some of their perceptual-motor problems at the same time.

For the purposes of the study a list of target behaviours was drawn up. It is necessary that there are targets for which one aims, and that they are as specific as possible in order to aid in the eventual evaluation of the outcome. The target behaviour, basically, was that the subjects overcome their perceptual-motor problems. This general target was, however, broken down into the various specific targets, which were relevant to the actual content of the training programme. Thus, the specific target behaviours of this study were the same as those for which the mine training officials aim.

There are four basic targets. The first is that the subjects learn to speak and understand Fanakalo, the lingua franca of the mines, so that they can follow instructions quickly, answer questions, and ask questions if they do not understand an instruction fully.

The second target is th` the subjects learn the appropriate behaviours relative to the tools to be used underground. The subjects must be able to name the tools, explain how they are to be used, and to demonstrate physically how to use them. The tools include a shovel; a chain; a nut and bolt; four, eight and fourteen-pound hammers; a pinch bar; a chisel; an eye-bolt; a straight spanner and a shifting spanner; pipes for water and air; a pick, support timbers and wedges; a rail spike and spike extractor; railroad track; a fish-plate; a drill; a track lifter; and explosive equipment.

The subjects' third target is to be able to perform the basic jobs necessary during the first three months underground. The jobs include installing supports, barring the hanging wall (roof) and face (side), sweeping, installing prop barricades, transporting timber, lashing (shovelling), operating scraper bells and scraper change over, building stone walls for ventilation, washing down, breaking up large rocks, caring for and storing tools, and assisting in the transport of explosives.

The final aim is to build up the strength of the subjects as quickly as possible for work underground. They must be able to begin work as soon as possible after arrival at the mine, and to miss as few days' work as possible due to illness or injury.

The experimental design included having two similar groups of subjects, drawn from a population which had been shown to have perceptual-motor problems. The control group was trained for work using the traditional mine practice of repeating and memorising the names of tools in Fanakalo. They also learned some basic sentences to help them express themselves, both at work and socially, to others whose home language was different. Safety lectures were also included.

The experimental group was trained by behaviour modification methods which have been shown to work effectively and in a relatively short time for children with perceptual-motor problems (Stephens, 1970). These techniques have not, however, as far as is known, been used for adults with the same problems.

2.2 An Overview of the Study

A review of the research relevant to the building up of perceptual ability was carried out for this study. Beginning with a short history of learning theory, an attempt is made to show how learning theorists began to identify the behavioural variables involved in perception. They thereby demonstrated that perception is not the purely mentalistic event it was previously supposed to be.

An analysis of perception which recognizes the overt behaviours involved in perceiving, allows one to deal with perception in a rational, experimental manner. One can vary the behaviours a subject is allowed to make and note any changes in his responses regarding what he perceives.

If a problem in perception exists, one can determine through behavioural-type tests and analyses, which behaviours are needed in the subject's

repertoire. It is then a straightforward process of enlarging his repertoire operationally. In the section regarding learning theory, a subsection deals with the operant procedures for modifying behaviour. Many of the procedures presented were used in the modification of the perceptual behaviours of the subjects in this study.

A survey of the literature of other theoretical orientations in the perceptual field showed that Piaget's theory (1952) is the source of many other theories of perception. These theories and the techniques derived from them are prominent in the treatment of children's perceptual-motor problems today (Kephart, 1971). Therefore, the Piagetian approach is also presented.

However, Piaget's theory is not stated operationally, so one cannot easily use his concepts, like 'primary circular responses' (Piaget, 1952). The concepts are all defined in terms of each other.

Therefore, an attempt has been made to define Piaget's terms operationally. The Piagetian theory was analysed, and his concepts re-defined, with the result that the theory looked very much like that of Taylor (1962). Taylor's experiments showed that perception is based on motor movements. The broader the range of one's movement experiences, the clearer one's perceptions.

When one has an underlying theoretical basis regarding the development of perception, one can make inferences regarding the learning of distorted perceptions and their treatment. It seems from the theory that perceptual dysfunctioning stems primarily from some lack in requisite motor learning. One can then apply therapeutic techniques that seem warranted by the theory (motor techniques) to each person according to his particular constellation of problems.

The therapy itself is individualistic. Each person may have a slightly different configuration of problems. Therefore an analysis of the specific problems of each individual is the next requisite. In this study, following the theoretical review, a behavioural analysis is presented. Mining officials have expressed, in operational terms, the problems the subjects have in reaching the target behaviours. These problems are presented in full. The subjects were then tested to determine their specific perceptual-motor deficiencies.

The problems of Malawian mine workers, in general, have been identified by the mining officials, in comparison with new recruits from other areas, as an inability to learn Fanakalo in a short period, a difficulty in learning to perform their jobs well underground, and a tendency to hurt themselves often at work.

The administration of selected items of the Purdue Perceptual-Motor Survey (Roach and Kephart, 1966) defined the individual subject's problems in terms of motor deficits, and gave the author clear ideas about which exercises to use for training. In perceptual-motor terms, the problems were found in the areas of differentiation of body parts, rhythm, depth perception and ocular pursuit.

A series of exercises was developed for use with these specific motor deficits, following Kephart (1971) and Mosston (1965). The exercises were analysed into the separate movements involved, and a chain was set up so that each subject could be shaped to the desired behaviour at his own pace.

For example, a subject having difficulty in differentiating arm movements from gross body movements would be taught to do "push-ups". He would probably have difficulty in doing this exercise immediately, so the exercise would be broken into its component parts and each behaviour would be taught consecutively until the desired full response was made. In the case of push-ups, the subject would first be reinforced for pushing his

upper torso off the ground, then for raising the upper torso followed by lifting the legs off the ground, and finally for raising his torso and legs in one movement. Eventually he would have to do this and also lower himself gently.

The subjects generalised their newly acquired abilities first by trying out the exercises involving the same muscle groups, for example by doing 'wheelbarrow' exercises, where one subject held the legs of another who 'walked' with his arms. Generalisation was continued by the subjects using the movements they had learned in a simulated work situation in a mock-up stope above ground.

The subjects were taught Fanakalo using operant methods instead of the usual methods. While the exercises were to improve the visual-motor abilities of the subjects, the language training was to improve their auditory-motor abilities. The normal training methods employed by the mines did not allow for auditory discrimination difficulties. The operant methods, introduced by the author, aided the subjects in learning a great deal of verbal material through the chaining procedure.

For example, the subjects first repeated single words and short, two to three-word sentences, and imitated the instructor's actions relating to those words. This is similar to the first lessons in the normal training procedure. However, in the experimental group those words were then used in other questions, answers, and commands. The subjects generalised on their ability to use all the words in this way. They did not merely memorise names, as did the control subjects.

Safety lectures were also given in Fanakalo, and mimed by the instructor. Teaching the subjects safe behaviour underground was dealt with more fully by the author than by the usual training methods. Every aspect of the experimental programme can be viewed as increasing the safety factor by increasing the subject's knowledge of what to expect underground.

Reinforcement tokens were given at the beginning of the experimental procedure to ensure a rapid increase in the subjects' rates of responding. However, with the introduction of the chaining procedure, the tokens became redundant, as the exercises were intrinsically reinforcing.

In addition to the tangible reinforcements, the African instructor was taught to give social reinforcement to the subjects.

Finally, it was necessary to determine whether the experimental group had, indeed, shown an improvement in their perceptual-motor behaviours, compared with the control group. The criteria for improvement were the re-test results for the two groups on the Classification Test Battery (1971). This is a perceptual test used by the mines to test the adaptability of men to underground conditions. In addition to this test, a checklist was administered to a sample of the shiftbosses who were well acquainted with the subjects' work underground.

It was hypothesised that the experimental subjects would do significantly better than the control group when re-tested on the Classification Test Battery, given that the pre-test results were similar for the two groups. It was expected that, on the checklist, the experimental group would be shown to perform better in the work situation than the control group. This was expected because the experimental subjects would have a greater range of experiences and behaviours from which to draw in new situations. They would have taken in a greater amount of information during training.

A detailed account of the exact procedure is given, and the actual results of this study are presented. These results are discussed and conclusions are drawn in a discussion of the results.

3 PERCEPTION IN BEHAVIOURAL LEARNING THEORY

3.1 A Short History of Learning Theory

The field of perception was not an area of study dealt with by early learning theorists. Those early behavioural scientists, like Watson (1924), emphasised the study of overtly observable behaviours. Watson initiated the attitude among psychologists that behaviour is important in itself. The observation and description of overt behaviours were of primary importance, but this stance has made it possible to define perception operationally. Thus, it is not now necessary to interpret behaviours, like perception, in mentalistic terms. Perception can be defined in terms of its observable correlates.

Watson adopted the conditioned reflex of Pavlov (1955) to explain how behaviours are learned. According to him, men acquired their behaviours through classical conditioning. He stressed that learning occurs when antecedent stimuli produce changes in an organism's behaviour. In order to predict and control behaviour by means of classical conditioning, one had to change the antecedent stimuli.

The classical conditioning paradigm was developed more fully by Hull (1943). He thought that the stimulus-response model was not effective in all situations. Many behaviours have no discernible cause, while some environmental stimuli cause no behaviours. To account for this, Hull postulated 'need states' within the organism.

Using the hypothetico-deductive method, Hull rigorously defined his terms, formulated postulates, set up experiments, and performed tests. If a test failed, the postulate was discarded, and if the test succeeded, the postulate was added to the body of scientific information.

Hull was able, for example, to define drive in terms of the number of hours of deprivation of the organism. He then brought in the notion of habit to explain how the behaviour was built up. The habit was defined as 'an invisible condition of the nervous system' (Hull, 1943). Thus, when external stimuli could not be found, internal ones had to be identified. Hull was forced to adopt internal variables.

The internal variables which came to be endorsed looked very much like the mentalistic processes which behavioural psychologists had vowed to dispossess. In reaction to this state of affairs, Skinner (1950) wrote an article in which he stated that scientists cannot talk about things happening when they cannot see them. Learning theory had to be a theory of behaviour. It must be concerned with what is happening instead of deducing what may be happening within man from what can be seen.

Skinner said that behaviour did not call for the use of hypothetico-deductive methods. He did not put himself in a position which necessitated the adoption of internal variables. 'Both behaviour itself and most of the variables of which it is a function are usually conspicuous' (Skinner, 1969).

One of the variables of behaviour important to him is what happens after a response has been made. Direct observation of behaviour and of the reinforcement contingent upon it is the necessary objective of the behavioural scientist, according to Skinner. The behaviours he looks at are operant behaviours, not elicited by stimuli.

Operant conditioning necessitates establishing the baseline and frequency of the important behaviour. The operant control of behaviour calls for contingency management through the use of modification procedures, such as schedules of reinforcement.

Skinner, thus, simplified for behavioural scientists the process of learning. When there is an observable stimulus associated with a response, manipulation of the stimulus will alter the response. When there is no stimulus, instead of assuming hypothesised internal variables, one must change other conditions and note how the behaviour varies.

By refusing to deduce mentalistic events from observable events, and, instead, experimenting with the observable behaviours, Skinner came up with what he calls 'contingencies of reinforcement' (Skinner, 1969). He has identified three independent variables which control behaviour - any behaviour. The variables are the response itself, the discriminative stimuli, and the reinforcement. The relationships amongst these three variables are called the contingencies of reinforcement.

Using contingencies of reinforcement in addition to the classical behavioural paradigm, it becomes easier to, firstly, observe and define behaviour, and, secondly, control it. Thus, it becomes possible to explore behaviour more widely. For example, one is behaving while one perceives as well as when one eats. The contingencies of reinforcement allow the scientist to study such internal material as perception by determining any behaviours antecedent or subsequent to the unobservable perception.

A review of the literature, done by Kimble (1973), indicates that fields such as perception are beginning to be explored by present-day behavioural psychologists. He indicates that a great deal more research is needed in such fields.

It is significant to note, however, that research in visual perception was already carried out by Taylor in 1962 along behavioural lines. He gave operational definitions to the concepts involved, based on experimentation by himself and others. He began with the experimental data of Koffka (1935) and the Gestaltists, but looked at those results in a different way. Taylor

re-analysed the results and discussed some of their important methodological errors, like using adult subjects instead of infants to infer principles of perceptual development.

Taylor's research led him to the conclusion that human infants do not learn in a different way from adults, and do not have sudden flashes of 'insight' into perceptual problems. Instead, our perceptual behaviours are built up gradually, through conditioning, as are all behaviours.

More specifically, Taylor says that human perceptions are learned by going through a series of motor manipulations. We learn to discriminate objects from our visual field by actually coming into contact with them, and we learn to perceive distance by covering the distance to an object on foot. Many such motoric movements cause us to generalise the behaviours, so eventually we can discriminate objects and estimate distances on the basis of visual perception alone. Basically, Taylor has shown that changes in behaviour can and do result in perceptual changes.

Thus, it is seen that the field of perception is an important and exciting new field for behavioural scientists. Perception seems to be based on observable motor movements made by an individual in his environment. These movements become less and less overt as the individual matures. The process of perception becomes internalized. However, research points to the fact that there are very slight but distinct motor components to every perception (Penfield and Roberts, 1959). It is through the definition of the motor components that behaviourists are beginning to explain perception.

3.2 Behavioural Definitions

To ensure that there are no misunderstandings, it is necessary in behavioural psychology to define one's terms. It is necessary, therefore, to define the terms to be used in this study. First of all, behaviour

itself must be defined. It is generally considered to be any observable movement of an organism, including both internal and external movements and their effects, and glandular secretions and their effects (Reese, 1966). This definition is currently being extended to include unobservable intrinsic behaviours, by identifying the external components of the unobservable behaviours (Cautela, 1969; Kimble, 1973). In the present study use will be made of the extended definition. Perception will be defined in terms of motor behaviours, which are to be experimentally manipulated.

In 1938 Skinner distinguished respondent and operant behaviours. A respondent behaviour is usually a reflex behaviour elicited by a stimulus. In respondent behaviour the stimulus must precede the response.

Skinner then defined operant behaviour as behaviour controlled, not by antecedents, but by consequences. He called the controlling consequences reinforcers. The class of responses on which a reinforcement is contingent he called an operant. This suggests an operation on the environment, followed by a reinforcement.

A reinforcer strengthens behaviour by increasing the probability of its occurrence. The increase in probability is measured by the rate or frequency of observable behaviour. A change in rate is said to indicate operant conditioning. Operant conditioning was used in this study to increase the rate of certain motoric behaviours in the subjects.

The consequences the environment has in increasing the organism's rate of responding can be either positive or negative reinforcers. Positive reinforcers increase the response rate when they appear, and negative reinforcers increase the response rate when they are made to disappear.

Skinner has concentrated on operant behaviour, the rate of emission of the operant and its probability of occurrence. However, he does not

ignore the stimulus conditions. Any stimulus present when an operant is reinforced acquires some control because of the temporal relation between it and the reinforcement. The stimulus is simply another aspect of the occasion on which an operant response is emitted and reinforced; it sets the occasion for a response.

For Skinner, the above three variables interact, and the inter-relationships between them are called contingencies of reinforcement, as mentioned earlier.

Through the application of the contingencies, one can condition virtually any behaviour, as long as the definitions of the variables are operational. Perception goes on inside the organism, but behavioural correlates of perception have been identified which can be manipulated.

In order to maintain any behaviour, one must generalise that behaviour to other situations. A behaviour which occurs in one stimulus situation is likely to occur in the presence of another related stimulus (Reese, 1966). If this were not the case, each response would have to be learned individually in every new stimulus situation. When this happens the behaviour is said to have generalised.

Reese (1966) notes that there is another side to that coin. There cannot be complete generalisation, or any behaviour might occur under any condition at any time. When one responds differently in different situations, one is said to discriminate. Sometimes it is necessary to increase the probability that discrimination will occur by reinforcing a certain predetermined response instead of other responses emitted by a subject. This is called differential reinforcement.

One final definition will suffice before going on to the methods of behaviour control. Sometimes it is not economical to wait for the response to occur in a particular stimulus situation. In that case one can gradually shape the behaviour required. One would reinforce behaviours that more and more closely resembled the ultimate response

desired. Finally, one would reinforce only the appropriate response, and the behaviour would be said to be shaped. Shaping was used a great deal in this study to condition the desired perceptual and motor behaviours in naive subjects.

3.3 The Control of Behaviour - Some Contingencies of Reinforcement

There are many techniques now experimentally verified which are used to modify behaviour. The methods of behaviour control can all be seen to be contingencies of reinforcement, as they all involve interactions amongst discriminative stimuli, responses and reinforcements.

One's behaviour can be seen to be controlled either by another or by oneself. In addition, there are procedures which increase the strength of a response and those which decrease it. Procedures to induce decrements in response strength were not used in this study, so they will not be discussed here. The contingencies relevant to this study will now be discussed and the characteristic response patterns will be given. These contingencies are discussed more fully in Reese (1966), Reynolds (1968) and Skinner (1969).

There are a number of procedures by which the strength of a response may be increased.

3.3.1 Respondent Conditioning

A specific unconditioned stimulus eventually elicits some reflex response and a specific conditioned response results. The appearance of the conditioned stimulus results in the increased frequency of the response.

3.3.2 Operant Conditioning

When a response is made, some reinforcement determines the probability of its future occurrence. The rate of responding increases.

3.3.3 Shaping

A final response is made more probable by reinforcing successive approximations to that result.

3.3.4 Schedules of Reinforcement

(a) Fixed ratio schedule: the subject is reinforced after every so many responses regardless of the time it takes to respond that many times. The response picture is one of a rapid rate of response, with a pause following reinforcement. The responses following reinforcement are never reinforced, so they become discriminative stimuli for non-reinforcement.

(b) Variable ratio schedule: the subject is reinforced after a different number of responses on each different occasion, the ratio being the average number of responses per reinforcement. The characteristic pattern is a sustained high rate of responding because reinforcement can come at any time.

Fixed interval schedule: once a fixed length of time has elapsed, the subsequent response will be reinforced. The characteristic pattern is a scallop, with a low overall response rate.

(d) Variable interval schedule: the subject receives a reinforcement sometimes sooner, sometimes later, than a previous one, the interval varying randomly over an average length of time. There is a low sustained rate of responding because the only way of getting all available reinforcers is to respond continuously.

3.3.5 Superstition

When a reinforcement is given every thirty seconds, for example, regardless of the behaviour of the organism, the behaviour occurring just before

reinforcement is reinforced. Similar coincidences become more likely and a superstitious 'ritual' develops.

3.3.6 Negative Reinforcement and Escape

When a response results in the disappearance of a negative reinforcement, that response will be repeated. Escape can be scheduled, with similar response patterns to positive reinforcement schedules.

3.3.7 Avoidance

A punishment is given to the subject every so often unless a response is made, which postpones the next punishment for that length of time. The rate of responding is increased and many punishments are avoided.

3.3.8 Imitation

A model makes a response and tells an observer to make the same response, usually in the presence of some object. When the observer responds correctly, he is reinforced. Later the model will merely point to the object and the observer will make the required response, which will be reinforced. The degree to which the model is imitated by the observer depends on many variables, for example, the consequences of the model's behaviour and the incentives offered to the observer for imitation. Imitation is still not completely understood (Bandura, 1969).

3.3.9 Stimulus Discrimination

A response is reinforced under certain stimulus conditions, but not reinforced under other stimulus conditions. The frequency of responding is greater in the presence of the discriminative stimulus (S^D) than in its absence (S^Δ).

3.3.10 Response Differentiation

A response is given only when a response is made above a given level (of force, correctness, or length of time, for example). Responses showing the required level of performance appear more frequently.

3.3.11 Chained Operants

One response becomes the stimulus for another response, which is then reinforced. The length of the chain can be increased almost indefinitely if done gradually. The frequency of occurrence of the chain of responses increases.

3.3.12 Matching

A response is made to one stimulus which results in two or more different stimuli being presented immediately, whereupon the subject must respond to that stimulus which matches the first. Responses to the matching stimulus increase in frequency.

3.3.13 Self-control

The subject seeks to increase the strength of the behaviour which he considers socially desirable, and to decrease the strength of behaviour which he considers undesirable. All the previously described contingencies of behaviour control can be used by the subject for his self-control.

3.4 Behaviour Modification

When it is possible to analyse and interpret behaviour in terms of its probability and in terms of the variables which have immediate effects, it is possible to predict and control behaviour. Using contingencies of reinforcement, Skinner has developed a technology of behaviour which is effective in behaviour modification. Contingencies can be arranged so that any kind of learning can be carried on. Perceptual material is learned in the same way as any other material. Internal behaviours follow the same rules as do observable behaviours.

3.5 Conclusion

Behavioural psychology is a field which is growing at a great rate. Men like Watson (1924) put behaviourism on a scientific footing by asserting that we may study only that which is observable. He said it was not necessary to make inferences from that to what may be going on inside the organism. Watson's psychology, however, only dealt with the respondent behaviours of the organism. He thought that all behaviour had to be sparked off by antecedent stimuli.

This classical conditioning position was found to be restrictive as more research was done. When some behaviours could not be elicited by stimuli and other responses were made without observable stimuli, Skinner postulated that the consequences of the response were affecting the conditioning. The operant conditioning paradigm of Skinner, in addition to the classical conditioning paradigm, explained behaviour more ully, without the necessity of inferring internal events.

Skinner and his students gave us many important tools with which we are now more precisely able to predict and control external behaviours. This methodology is now being refined to the point where it is possible to apply it to such aspects of behaviour as perception. Although perception is a behaviour one cannot observe directly, some behavioural correlates of perception have been identified and it is possible to observe and control them.

With the definition of unobservable intrinsic events in terms of observable, manipulable events, it is possible to treat subject matter such as perception according to the same general rules as observable behaviours. Perception will be treated in this study as private responses, following Keehn (1964), which are observable in external motor behaviours. Thus, perception will be dealt with as would any other observable behaviour, in terms of contingencies of reinforcement.

4 THE PIAGETIAN THEORY OF PERCEPTUAL DEVELOPMENT

4.1 Introduction

A look at Piaget's theory of perceptual development is necessary here as his theory has influenced many workers in the field of perception. It was from Piaget that Kephart (1971), one of the leaders in the field of perceptual-motor therapy, developed his techniques for use with perceptually disordered children. Unfortunately, Piaget's, and hence Kephart's, theory lacks clear definitions of terms. On close inspection of the literature the theory loses much of its impact due to the many circular definitions.

Piaget also bases much of his theory on the assumption that the infant has an innate experience which he consciously develops. The infant's learning process is said to proceed differently from that of the adult. The assumption has little value in a scientific theory as it cannot be proved or disproved. However, one aspect is stated operationally and lends itself to this study. That is that action - motor-movement - precedes perception.

Thus, although Piaget's theory has some limitations, it has importance for anyone concerned with the area of perception. In order to minimise the limitations, and make the theory operational, an attempt is made in the following section to re-define some of the Piagetian theory into behavourist terms. The work of Taylor (1962) is drawn upon to aid in re-defining Piaget's terms.

In this section, Piaget's basic theory is put forward, showing the relevance it has to the present study, but also identifying some of the problems with the theory.

The Piagetian theory is especially important here because of his influence on Kephart (1971). Kephart has developed some very successful motor training procedures which have been shown to aid in the development of perception in children. This is important to this study. Once the motor correlates of perception are identified, it is possible to tell where the motor deficiencies lie in a group of subjects. It then becomes necessary to develop the areas of motor deficiency. Kephart's techniques have been shown to do this (Godfrey and Kephart, 1969; Chaney and Kephart, 1968). Kephartian training procedures were, therefore, used as a point of departure in determining the physical training procedures for this study.

Before going on to determine how Kephart derived his methods from Piaget, it is necessary to outline Piaget's theory and get an understanding of some of his terms and the basic concepts of the theory.

4.2 Basic Premises

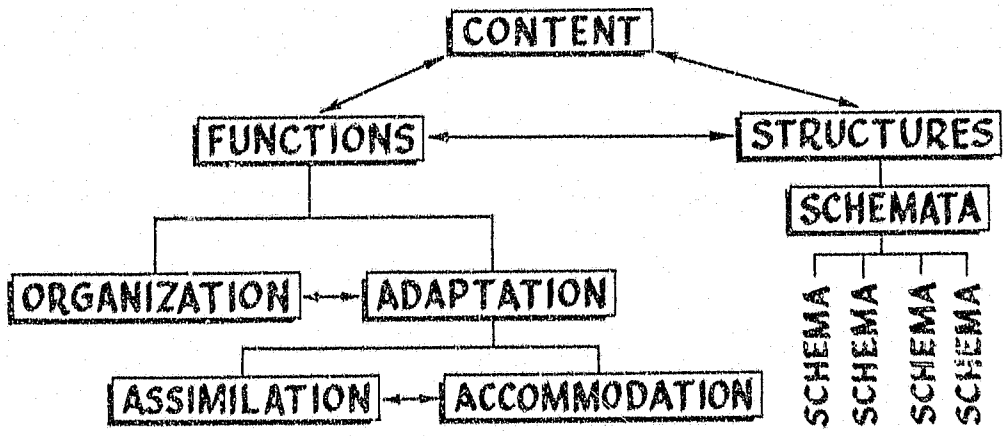
For Piaget the main orientating attitude has to do with the nature of intelligence, how and why we grow intellectually. The growth of perception is, however, basic to the growth of intelligence since all knowledge is acquired through the senses. Essentially, Piaget regards perception in terms of its content, structure and function. He assumes that functions and structures are internal ongoing processes.

Functions are, however, biologically inherited processes which must remain unchanged, whereas structures vary as the individual develops. Basically there are two functions: organisation and adaptation. These two functions impose conditions on the structures. Difficulty with the definitions arises here because it is not possible to define adaptation without bringing in two new concepts which are then defined in terms of adaptation.

Those two concepts are assimilation and accommodation. Assimilation occurs when a subject takes something from his environment and incorporates it. In the process of assimilation both the data incorporated and the subject himself are changed to fit the existing internal structures. Accommodation occurs, at the same time, when the data being incorporated changes the internal structures.

Balance between assimilation and accommodation is most conducive to learning. When a balance, however temporary, occurs, adaptation is said to be taking place. Then one's genetic mechanisms organise the adapted information.

There can be any number of schemata, or central processes, which are changed and in turn change the organism. They make up a type of structure or framework with which we assimilate and accommodate data, so that the framework is always changing. Again there is a temporary state of balance within the framework of schemata when learning is taking place. Equilibration occurs during this period of balance. But the organism can then notice inconsistencies in the structure that were not apparent before, so that equilibrium is lost again until the organism has more information. The following figure shows some relationships (adapted from Phillips, 1969) :



Another of Piaget's basic premises is that to understand the process of perceptual development one must consider the child's manipulation and organisation of objects (Maier, 1969). He made detailed observations of his children's manipulative behaviour, and the behaviour directed toward objects in the external environment. Such directed behaviour includes holding the head still when looking and listening (perceiving). Although there is no gross motor behaviour, there is muscle innervation. A sensitive instrument will show up some movement. The point is that there is always an active interrelation between the child and the environment.

Thus, all behaviour - motor, perceptual, and eventually conceptual - is conceived of as active responses of the child, and not merely as subjective experiences. When long sequences of conceptual behaviour (thinking) occur, it may be difficult to find any relation to previous or subsequent actions. However, the premise is that perceiving or thinking cannot be discussed separately from action in the environment. Action precedes perception and thought, and the processes of perceiving or thinking eventually result in action.

This aspect of the theory is the only part which is relevant to this study. It is the one part of the theory which suggests an operation, and, thus, is an operationally-viable premise.

It was this aspect which Kephart (1971) chose to enlarge upon in his own work. He felt that if the child could engage in more motor behaviours and physical interactions with objects, his perceptual behaviours would improve. With more physical experience, the child would be better able to match and classify objects and symbols - a prerequisite to reading and calculating.

4.3 Piaget's Influence on Kephart

Although Piaget did not construct his theory as an aid to education, many educationists have used his theory as a basis for perceptual remediation methodologies. Kephart's (1971) system seems to be the most comprehensive and well organised of all those remediation technologies.

Kephart has taken Piaget's assertion that action precedes perception, and built up a programme for training perceptually deficient children. Since he bases his theory on Piaget, he also uses Piaget's definitions as a basis for his own. Fortunately this did not deter Kephart from devising operational techniques which directly enhance perceptual behaviour.

For example, in theory Kephart maintains that the infant develops a sort of internal map, or 'body image', from his interaction with the world, viz. manipulating objects. The internalized body image is gradually, through experience, extended outward to encompass the space that surrounds the child. Thus, he has a series of 'maps' with which to control his behaviour.

These mentalistic concepts are exactly the kind which behaviourists want to abandon. They give no indication as to how one is to manipulate them. Therefore, in the next chapter, these terms will be re-defined according to behaviourist conditions. Nevertheless, it is necessary to describe briefly Kephart's theoretical definitions.

Basically, through action, or 'perceptual-motor', activities, one learns 'laterality' and 'directionality'. Laterality is said to be an internal understanding of the concept of right and left. The infant cannot label the right or left, but learns to move one side of his body or the other in response to the environment. Gradually this concept becomes exteriorized to external as well as internal space, and is called directionality.

The quality of directionality allows one actually to label the directions of right and left and, later, up and down, forward and backward, etc. Through the use of directionality and laterality one controls one's behaviour, and with more perceptual-motor experience the control of behaviour becomes more precise.

The visual perception of the space surrounding the individual is emphasised in Kephart's theory. Vision is the most important faculty in the accumulation of knowledge. One's movements within that space are basic to further perception in the environment. When a child fails to develop a visual spatial framework, he does not have a rational basis for future information accumulation. His learning takes place in patches because he does not perceive the total situation.

Without a complete spatial framework, the child, for example, does not have the experience of boundaries or forms. He does not have a basic set of experiences against which he can test new information. Usually he resorts to merely memorising information; hence, his uneven scholastic progress.

Kephart has developed a number of sensorimotor techniques for dealing with perceptual deficiencies in children. He first determines the locus of the problem using the Perceptual-Motor Survey (Roach and Kephart, 1966). He treats each case individually, and neither advocates nor uses the "cookbook" approach. Depending on the deficiency, the child, and the environment, Kephart prescribes certain motor tasks. This procedure is within the behavioural framework, as it is definitely operational.

Sometimes remediation requires the use of apparatus, but often simple physical exercises done under special conditions are all that is required. The exercises help the child to develop laterality and directionality. In other words, he develops a body image, or an idea of his position in space.

When remediation procedures are put into effect, Kephart maintains that the importance of the procedure is in teaching a generalised ability rather than in teaching a specific skill on a specific piece of apparatus. Only through generalisation are the concepts of laterality and directionality learned. In his definition and use of the term generalisation, Kephart is in agreement with the behaviourists.

By way of an example, Kephart's use of the balance board is apposite. The apparatus consists of a beam, five centimetres by ten centimetres, and three to four metres long. The beam can be used flat on the ground, or can be raised, using brackets, to allow for another dimension of movement, viz. bouncing up and down.

The child's task is to walk along the beam slowly from one end to the other, maintaining his balance. The child can walk forward, backward and sideways on the beam. Then it may be beneficial for him to try other balancing tasks like walking to the centre, turning around, and walking back; walking to the centre, kneeling to pick up an object, standing and walking to the end. Two subjects can use the beam simultaneously, starting from opposite ends and passing each other at the centre.

The use of the balance board aids the child in the development of balance under many different conditions. By maintaining balance in different situations, he learns to generalise that ability. Through his movements when he rights himself after losing balance, he gets kinesthetic feedback which emphasises his laterality.

Other exercises are then devised to help him generalise his laterality further. More complex exercises are then prescribed which help him develop laterality and directionality. Chaney and Kephart (1968) give a detailed description of various techniques, together with examples of appropriate uses for them.

In Piagetian terms, Kephart requires the child to perform a novel task at a very simple level, so that unfamiliar kinesthetic inputs can be assimilated. Assimilation takes place only if the task is discrepant, but not too discrepant, from his present abilities (structures). In the process, the present structures will also be accommodated. The aim is to keep the discrepancies optimal, so that the child is motivated to keep active. Through activity he is gathering the necessary perceptual material in which he is deficient.

Research has shown that Kephart's techniques have value in the remediation of perceptual difficulties of children (Dunsing, 1963; Dunsing and Kephart, 1965; Godfrey and Kephart, 1969; Ismail and Gruber, 1967). It was therefore thought desirable to use modifications of these techniques in this study with adults. On the other hand, it was considered inappropriate to use mentalistically-based procedures in a behaviourist thesis. A re-definition of the theory is therefore submitted in the following section. As Kephartian theory is shown to fit into the behaviourist mould, it was regarded appropriate to use Kephartian procedure in this study.

4.4 Discussion of Piaget's Theory

The most serious doubts regarding Piaget's theory have been expressed in regard to the validity of his method of investigation. Although he says his method is suited only to the description and explanation of the growth of intellect, his "clinical" method is poorly controlled from the standpoint of experimental design. Nathan Isaacs (1963) says, "there is much to object to, and even to reject, in the way in which most of his material seemed to have been gathered." (p.83)

This statement can be examined in terms of Anderson's (1968) criteria for experimental design, and Piaget's method falls short on each of five counts.

(i) Operational definitions. Piaget seldom defines his terms, and when he does it is in terms of his other concepts. These circular definitions do not fulfil the first requirement.

(ii) Sampling. Piaget used only his own three children, and other workers have used only a very small sample of children in trying to replicate the original studies. They did not include, within each phase, children with a full range of intelligence and from different backgrounds.

(iii) Control. There was no standardised interviewing technique; in fact, Piaget's method precludes such a technique. He relies, instead, on good rapport with the child. Rosenthal and Fade (1963) have shown how the experimenter can effect the results even in the behaviour of rats. Susan Isaacs (1963) found, in children, that Piaget's method was subject to an experimenter effect and, thus, his experiments were difficult, if not impossible, to replicate.

(iv) Statistics. Because of small samples, Piaget provides few, if any, statistics. There are generally no measures of variance, which, it seems, would be considerable. There are no tests of significance, his methods do not allow for that. Instead he puts forward categorical statements, concerning children in general, from studies (granted that they are in detail) of only a few children.

(v) Generalisation. Piaget studied his own three children and generalised from them to the "universal child". Then he showed that his children were ahead of others in their cognitive development. The validity of Piaget's norms, therefore, have been questioned (Donaldson, 1963). In particular, he seems to have over-generalised extensively from his limited experiments.

Another criticism of Piaget's method is that, because his experiments were conducted in an artificial situation, the data observed does not approximate the real level of a child's development in a natural setting (Ginsburg and Opper, 1969). This was especially so for the experiments in the last two periods, where Piaget simply wanted to show how closely the child approximates the philosophical principles of logical thought. This situation does not allow for development due to specific experience. Susan Isaacs (1963), working at the Malting House School, observed children continuously in an unstructured situation. She found that experience played a much larger role in development than a strict process of maturation. Furthermore, she found no hard and fast notion of mental structures evident in the children's experience.

Flavell (1963) has suggested that the most serious criticism of Piaget is that he worked according to his own set of rules, conducting experiments to satisfy himself with little regard for the general psychological community. From there Piaget proceeded to the construction of a theory! Boyle (1969) has supplemented this criticism, saying :

> " ... it can be said of Piaget that he conducts his experiments to illustrate his point of view, rather than to gain new knowledge." (p.141)

This criticism seems to cover all the previous ones. It gives an indication of the importance of interaction with one's colleagues so that one does not stray too far from that which can be examined scientifically.

4.5 Conclusion

The Piagetian theory of perception has given rise to many techniques for the alleviation of perceptual deficiencies, especially that of Kephart (1971). Kephart starts from Piaget's premise that action is the basis of all perception. Therefore, any dysfunction in one's perception is the result of a motor deficiency.

Kephart, unfortunately, defines his terms mentalistically, in the Piagetian tradition. He uses concepts such as laterality and directionality, which the child is said to develop through motor experience. If the child is deficient in motor experience, he does not develop an image of himself in the environment, and does not have a basic information set with which to perceive the world and accumulate new information.

Kephart helps the child assimilate the necessary laterality and directionality through generalised motor tasks. Assimilation takes place when the tasks are ordered in degree of difficulty to maintain a high rate of activity. At the same time accommodation takes place, as the child's information set is enlarged.

Although the theory is mentalistic, and the terms are difficult to submit to trial, the remedial techniques seem to show a great deal of promise. They can be seen to be operational. If the theory could be translated into operational terms, it was believed that it would be possible to use modifications of the techniques in this study with perceptually-deficient adult subjects.

5 A RESTATEMENT OF PIAGET'S THEORY IN BEHAVIOURIST TERMS

As was mentioned in the previous section, Piaget attempted, through his research, to show how and why a child develops perceptually by his passing through a certain set of stages. However, he did not show that the progression he suggested was, in fact, necessary, nor was he able to show by which process the child progressed from stage to stage. (He defines his terms in a manner that makes them of no value in determining how a child develops.) It would seem that his observations, and the remedial techniques that stem from them, could be a valuable addition to psychological literature if they could be put into a workable frame of reference. His premises are therefore restated operationally so that it becomes possible to use the remediation techniques which are a result of the theorising.

5.1 Piaget's Terms Re-defined

Piaget works from a premise similar to that of Hebb (1949), that learning in early infancy is somewhat different from that in adulthood, i.e. that there are two different kinds of learning. One kind is learning through experience, the other is an inherited learning process that goes on without the individual being able to do anything about it. Piaget calls the inherited way of learning a function and the learning through experience he calls a structure. He is of the opinion that the two kinds of learning modify each other all the time.

Taylor (1962) argues that there is no basis for such a view of learning. He cites a great deal of research to demonstrate that the supposed inherited learning by the individual is actually classical conditioning. Taylor argues that Hebb, too, is viewing behaviour, in this case the reflex behaviour of looking at a relatively high intensity

source of light, after that behaviour has already been partially conditioned, and then Hebb reasons that that behaviour must have been part of the infant's inherited experience. Taylor gives an example of how the infant's reflex behaviour is conditioned in the classical manner.

It is important here, as well, to adhere to that which is verifiable rather than to hypothesise constructs which are impossible to test. Therefore, instead of using Piaget's functions and structures, which are seen as two kinds of learning, we shall use one kind of learning, namely that of conditioning.

Now, if we follow the figure that Phillips (1969) uses, we have content, that which is observable in the interaction between the child and his environment. That definition is adequate. That which we observe is learned, then, not by two different kinds of learning but by one, viz. by conditioning. There is classical and operant conditioning, of course, but they are not two separate processes.

From this point it is difficult to stick to Phillips' diagram, because we do not need so many terms to define the learning process. Nevertheless, let us see what Piaget means by his terms. He says we organise information according to a biologically inherited mode of interacting with the environment. Every act is organised, and then adapted into the existing body of knowledge. It seems that here we must define what Piaget calls organisation as what is physiologically going on in the brain. It is beyond the scope of this study to go into this in detail, but the barest outline will suffice.

Organisation becomes the firing of neurons across synapses (Eccles, 1953) as some external object or person comes into the child's perceptual field. When the child sees, touches, smells, or tastes a new object, selected neurons in the brain fire and a neural pattern is started that progressively alters with use (Lorento de No, 1947). If the child

perceives many similar objects, that neural pattern will strengthen so that the neurons fire more easily across the synapses. In other words, the information becomes generalised. If the child does not perceive many more similar objects, the neurons will not fire so easily, but the neural pattern will remain, weak and inefficient as it is. At this point it is relevant to point out that whether the psychological process is carried on depends on conditioning, that the learning of any information depends on its being presented to the individual and on his being reinforced. The synaptic process depends on conditioning, whether overt or not.

Once the information is organised, that is, the synaptic links have been conditioned, the information is ready for adaptation. Piaget is not clear on this term, but he seems to mean that the information is ready for use. Once the child has a neural pattern for the sight, smell, and taste of his mother when she feeds him, that pattern is activated whenever his mother comes into view, and very soon after birth the child "recognises" his mother. He has been reinforced, for example, given milk, in the presence of a conditioned stimulus, his mother, who can become a generalised conditioned stimulus for any number of later desired behaviours. A behaviour chain can be set up. Taylor (1962) has been very clear on this. It is not that the child learns in a different way, according to some immutable biological process. The child learns, as we all do, through the conditioning of a series of behaviours, each built on the previous one.

If it is difficult to conceive of an infant being conditioned at so early an age, reference should be made to Siqueland and Lipsitt in Bijou and Baer (1967) on the conditioning of head turning in human newborns. It can be seen that the infant, just after birth, has all the necessary environmental conditions for discrimination, and that the infants in the study cited learned to turn their heads to the side from where the reinforcement came. With the refinement of experimental techniques, it is now

possible to analyse behaviourally infant behaviour, to change reflex behaviour quickly into conditioned chains of behaviour, and even to detach the original eliciting stimulus from the reflex by using new reinforcement contingencies (Bijou and Baer, 1967).

The term, adaptation, is more fully explained by Piaget as the process of assimilation and accommodation. In behaviouristic terms, we would say that assimilation is the reinforcement of discrete bits of information, while accommodation seems to be the reinforcement of these behaviours into generalised chains of behaviour over time.

Piaget says these processes of assimilation and accommodation operate in the same way regardless of the information being learned, which is also true from a behaviourist point of view, and that the processes of assimilation and accommodation modify each other. The evidence shows that learning a chain of responses begins with the reinforcement of individual responses, and that the chain of behaviours is changed and strengthened with the addition of a new link to the chain and a final reinforcement (Ferster and Perrott, 1968).

Piaget finally defines schemata as structural units which do change, depending on the information learned. In behaviourist terms, these schemata would be better defined as the chains of behaviours which result from conditioning of individual behaviours, and, thus, are equivalent to what were defined as the contents. So it is seen that Piaget's terms are circularly defined. He uses many more terms than necessary. (Although the ideas look good on a diagram, they are impossible to see in action.)

A different, very much simpler, explanation now emerges. Many learned discrete behaviours become reinforced and generalised into complex chains of behaviours, through operant conditioning. Those chains then become the bits of information to be used in even more complex chains.

Having found fault with Piaget's definitions, it is also noted that Bruner (1959) could not find evidence to support Piaget's stage theory. However, that is not to say that there are no stages through which an individual must pass. It simply means that there is no absolute pattern of stages through which one must pass in a certain order. The order in which chains of behaviour are learned depends on the environment, and the experiences we have within it.

The final premise of Piaget, that the organism must act to develop his perceptual ability, does seem to have value for this study. However, Piaget (1955) says that the child acts to exteriorize his innate inner world of experience! Taylor (1962), instead, describes in behavioural terms how physical movement is necessary for the development of perception.

The child, in Taylor's view, does not have two different kinds of experience, internal and external, but rather he has a multitude of experiences, all gathered by means of conditioning. All development follows the same process according to Taylor, and that process involves the reinforcement of responses - and, to begin with, the reinforcement of motor responses. A child is born with a certain number of motor reflexes which are reinforced in the environment. More complex behaviours are developed through operant conditioning. The child then begins to perceive his actions in a hazy way, and gradually the perceptions become organised on the basis of his actions.

5.2 A Behavioural Outline of Perceptual Development

A new outline can be drawn up, in terms of the behavioural definitions, to show the developmental process of perception. Perceptual development, like all development, follows the same laws, namely those of conditioning. This is the most parsimonious view, and thus, in traditional scientific procedure, the best view.

At birth the infant has a few reflex behaviours. He has the palmar grasp, the orienting response, the sucking reflex, and so forth. By conditioning the child learns which way to turn his head in response to a discriminative stimulus to receive reinforcement. He learns to discriminate sucking a nutritive object from a non-nutritive one.

When he kicks his legs and waves his arms, he may accidentally set in motion a toy on his cot. If that is reinforcing for him, he kicks his legs and waves his arms again.

He, in other words, develops a set of discrete behaviours. These behaviours are soon developed into chains, or behaviour patterns, through reinforcement. There is no need to say that from some stage the behaviours are acquired, whereas before that they were not. All behaviours are acquired through conditioning and the building up of behavioural chains.

Piaget gives most of the credit for learning to the individual. It is, according to him, the child who acquires behaviours consciously. The infant tries to reproduce an effective behaviour so that he can complete a "primary circular response". This is unnecessary. When a behaviour leads to an advantageous result by accident, the child may be reinforced by that result. He can go through the same motions again and can again be reinforced.

No different principles are necessary for learning at any age. When the infant has built up a few chains of behaviour, those chains become the behaviours on which he bases more complex chains.

For example, an infant learns to turn his head toward the source of nourishment, to vocalise when his mother is near, and to hit the toy in his cot. All those behaviours are chains in themselves. They can then develop into a more complex chain, such that, when the infant is alone in his room, he kicks the toy and makes a noise that his mother hears.

She comes to his room, smiles and talks to him. He babbles to her, she picks him up and holds him next to her breast. He turns his head toward the breast, she sits down and feeds him. This chain can be presented in a way that describes the behaviours in detail and makes it possible to prove that each stimulus in the chain is actually the reinforcer maintaining the performance it follows.

DISCRIMINATIVE STIMULUS (S^D)	RESPONSE (R)	REINFORCEMENT ($S^{rein.}$)
1 Toy in cot	Child kicking toy	Sight and sound of toy
2 Sight and sound of toy	Child kicking toy	Mother enters room
3 Mother enters room	Child looks at mother	Mother smiles and talks to child
4 Mother smiles and talks to child	Child babbles	Mother picks up child and cuddles him
5 Mother picks up child and cuddles him	Child turns head to breast	Mother gives breast
6 Mother gives breast	Child sucks and swallows	Physiological changes in child

This chain of behaviour becomes strong through frequent reinforcement, the physiological abatement of hunger, and the chain is then built upon again. All behaviours are built up from just such simple chains as that presented above. For example, the child's kicking can be developed by the mother more exactly. She can interrupt the chain to pay more attention to his kicking, and shape his behaviour so that he kicks in a more co-ordinated or rhythmical way. She can turn him onto his stomach and encourage kicking in that position. She must just be sure that he receives his final reinforcement. Eventually, from shaping his kicking responses, the mother encourages her child to push with his legs, creep, crawl, and ultimately walk and run. The same procedure is followed to change babbling into speech.

Thus, it is necessary only that the child be conditioned in order to develop. There is no other different kind of learning process that must go on. However, it must be noted that all adult behaviours inevitably begin with motor behaviours. Taylor (1962) is clear on this. His theory seems to be sufficient to explain how motor behaviours are a necessary prerequisite to perceptual learning. Taylor concerns himself mostly with visual perception; however, he is careful to note that all perceptual processes follow the same rules, namely those of conditioning. He shows that internal events too, develop according to the same laws that determine external and observable behaviour. The external, or motor, behaviour must develop first, according to Taylor's research, and from that the individual gradually develops his ability to perceive his environment visually in a clear and organised manner.

5.3 The Use of Kephart's Techniques within Taylor's Framework

Kephart (1971) gives useful techniques for use with children who have, for some reason, not learned the necessary motor behaviours and have difficulty with perceptual behaviours, especially at school. Kephart's theory follows from Piaget's and he makes statements like: "the child moves about in his environment for the purpose of contacting and interacting with it", (Kephart, 1971), (italics his). However, with the restatement of the theory, it is possible to use his techniques in a behavioural study.

First, the gross motor movements are made and are followed by perceptions, although the infant's perceptions are not the same as adults know them. According to Harlow (1951) the new-born sees only ill-defined masses which differ from one another only in area, intensity and colour. As adults, we perceive first and then act in response to that stimulation, but infants, in order to begin to discriminate elements in their hazy perceptual field, must act first. However, the infant does

not act in order to contact the environment. He exhibits a few reflex actions, is reinforced perceptually (through taste, sight and so forth) and repeats those movements. Thus, every action is followed by some perception, the perception acts as a reinforcement for the action, and the action is repeated. The action leads the infant to distinguish and generalise various perceptual patterns in his environment.

As the infant matures by this process of conditioning, he differentiates more and more people and objects in the environment, but at first he does so only in relation to himself (Taylor, 1962). Kephart calls this egocentric localisation, where the child locates two objects in space, independently of each other, but in relation to himself. Thus, the environment is perceived as changing its position in relation to the child's body with each one of his movements. A corollary of this statement is that the child perceives his environment, but does not at first perceive his own position in it (Taylor, 1962).

At the same time that the child is learning to make movements and to perceive, he must learn to respond to gravitational stimuli. Einstein (1955) tells us that gravity is the one constant in the spatial world, and it is the point from which all explorations begin. In our movements, it is necessary that we maintain a consistent orientation to the gravitational force, so that we can orient to the world around us in a consistent way and so that we can safely and efficiently move around in the environment.

As Taylor says, maturation is a necessary but not a sufficient cause for development of motor responses. One must also consider learning, by which the child perfects his abilities, in this case, the ability to orient himself to gravity. The first observable learned response to gravity is the infant's ability to control the rolling movements of his head, as his position is changed (Taylor, 1962). Through his

orienting responses to gravity, the child ac a horizontal-vertical frame of reference by which his perceptions are organised. The vertical axis is perceived as being absolutely constant, while the horizontal axis is perceived as changing, depending on whether the child is crawling, sitting, or walking. Kephart (1971) says we develop laterality, a learned internal frame of reference.

Gravity and perception, however, have been found to interact. It is not simply that the child organises his perceptions by reference to a gravitational axis. He also derives his horizontal-vertical frame of reference, to an extent, from his perception of the external environment (Taylor, 1962). Witkin's (1949) studies, in which subjects sat in a tilted chair in a tilted room, show that there is a wide range of variation in the perception of the vertical, depending on the subject's learned perception of the external environment (the subjects had head and arm rests, and thus did not have muscular cues as to their position, but only visual). The subjects were rotated, blindfolded, back and forth in the chair, and brought to rest in the vertical position, but with the room tilted thirty degrees, and then had the blindfold taken off. ome subjects perceived themselves as tilted, while the room was seen as vertical. Others perceived themselves as vertical and the room as tilted. The first group was called field dependent and the second was termed field independent.

Witkin found that the field dependent subjects had histories of overprotection. This could mean that those subjects had not been allowed to explore physically their environment as fully as the field independent subjects. They had not been reinforced for many motor responses and, thus, had not perceived their environment from many different orientations. The difference then can be seen as a difference in what perceptual data was learned, and not as a difference in basic personality structure.

In the case of visual perception, Kephart agrees with Taylor that perceptual data aids in the learning of muscular orienting responses. Thus, again perception and action interact. One is not solely the result of the other. Kephart says that eye-hand co-ordination is a learned series of matches of eyes to hand movements, so that the eyes come to control more precisely the movements of the hands, which already had developed some control when the hand controlled the eye movements. He, thus, agrees that the child must perceive a situation in order more fully to develop his frame of reference, or his laterality.

The child continues to develop slowly, and, through the perception of his environment, he begins to project the internal horizontal-vertical frame of reference onto external space (Taylor, 1962). The child experiments by moving toward objects in space, for example, his eyes following the movements of his hand, he moves toward and reaches for a toy straight in front of him and then toward another toy to his right. Through a number of such experiences, he learns to view the objects in space in relation to themselves, without having first to relate them to himself. Kephart calls this the development of directionality, and through this process the child develops what he calls objective localisation. In other words, he perceives one object as being to the right of another object, without perceiving them relative to himself.

Through the conditioning of the first motor reflexes, through the subsequent differentiation of the perceptual field, and through the learned adaptation to gravity, the child builds up complex chains of behaviour. For every perception, there is a motor behaviour, so that the chains involve perceptual-motor behaviour.

An example of a chain of perceptual-motor behaviour might be as follows. Note the interaction of the action and the perception in the response column overleaf.

S^D	R	S^{rein}
1 A teenager on a basketball court with basketball	He drops the ball to the floor	It hits the floor and bounces back
2 It hits the floor and bounces back	He sees it bouncing up	Ball is within reach to be hit (dribbled)
3 Ball is within reach to be dribbled	He strikes ball	It hits the floor and bounces up again
4 Ball hits the floor and bounces up again	He sees it bouncing toward him again	Ball is within his reach
5 Ball is within his reach	He grasps ball	Ball in his hands
6 Ball in his hands	He looks up at basket and aims ball	Basket in his line of vision
7 Basket in his line of vision	Throws ball at basket	Ball hits backstop and bounces back
8 Ball hits backstop and bounces back	He sees that he missed basket and ball is coming back toward him	Ball is within reach
9 Ball is within reach	Catches ball	Basketball in his hands
10 Basketball in hands	Looks at target again and aims ball	Basket in line of vision
11 Basket in line of vision	He throws ball toward the target	Ball is deflected off backstop and goes through the hoop
12 Ball goes through hoop	He sees he has made a "basket"	Has the beginnings of perceptual-motor behaviour which may make him a part of the team

Once the child has developed some perceptual-motor behaviour, it is important that he generalise that behaviour, by being reinforced for making many similar, but not exact, elaborations of it. A relationship is established between the various elaborations of the behaviour through the reinforcement of successively more varied generalisations. Kephart says that this process goes on automatically in the brain with no reinforcement - except in the case of children with learning difficulties. It seems a much better idea to hypothesise that all people need reinforcement in order to generalise their learned perceptual abilities, and that perceptual dysfunction results from a lack of reinforcement.

It is a hypothesis of this study that the reinforcement of motor behaviours will aid in the perceptual development of adults who have not had the necessary environmental stimulation and reinforcement to acquire well organised perceptions.

At the same time that the individual is generalising his newly learned behaviours, he learns to discriminate perceptually forms, distance, and time. Through the motor behaviour of touching, the individual learns to discriminate shapes. Through walking toward and away from objects, and putting himself in the place of the objects that he sees and touches, he learns to gauge the distance between them. Through the development of co-ordination, or rhythm, in motor, visual, or auditory areas, the individual develops awareness of equal temporal intervals and learns to locate objects in time.

The way in which the individual goes about learning these discriminations is, however, no different from any of the learning that went on previously when he was learning as an infant to differentiate specific objects, sounds, and tastes from his given perceptual data.

3.4 Conclusion

This section has been a restatement of Piaget's terms into behavioural terms, and a general review of the behaviourist theory of perceptual development. It has been shown how it is possible to translate Kephart's terms into behaviourist terms. It therefore became possible to use Kephart's techniques in this study.

We have seen how the child learns chains of perceptual-motor behaviours through conditioning, beginning with the reinforcement of motor behaviours. He hazily perceives his movements and gradually learns to differentiate certain stimuli from those first hazy perceptions.

However, people often are not reinforced for many of their actions so they do not build up organised perceptions in many situations. Note the findings of Witkin (1949), who found that many children at advanced ages could not identify their own vertical axis. A great deal has been written about children with perceptual dysfunction, its cause, and cure (Bender, 1956; Cruickshank and Johnson, 1958; Johnson and Myklebust, 1967; Frostig, 1970; and Kephart, 1971). Regardless of the cause of this problem, it seems that reinforcement must play a role in the amelioration of it. The individuals must learn to differentiate perceptually distinct objects, and to generalise their perceptual ability. It seems probable that this can be done through the conditioning of motor movements, so that the individuals can perceive themselves in many different situations.

So, from the statement in this section of the most advantageous developmental process, that of conditioning, we will continue in the next section with the behavioural strategies for correcting perceptual problems which occur in individuals who have suffered from faulty reinforcement contingencies.

6 BEHAVIOUR MODIFICATION : THE APPLICATION OF THE THEORY

It is more difficult to specify and manipulate the variables when dealing with humans in everyday life situations than it is with animals in a laboratory. However, the behavioural procedure is the same for the conditioning of any species. One must be as specific as possible, in this case regarding what is observable about human perceptual behaviour.

A bare outline is presented here of the procedure one would adopt to condition operantly any behaviour in humans. No attempt is made in this section to specify the variables which were manipulated in this study. That information is presented in the methodological section.

6.1 The Method for Behaviour Modification with Humans

Once it has been decided which are the general problem areas, it is necessary to establish the baseline level of proficiency for the group in that area. This can be done by administering a test, by watching the subjects as they perform naturally in the problem area, by interviewing others who know the subjects' behaviours, or by a combination of these procedures. The dual method of testing and interviewing mine personnel was used in this study to establish a baseline of perceptual-motor behaviours.

The initial analysis included finding both excesses and deficits in the subjects' behaviour. It is helpful to have an idea of what seems to be maintaining or retarding the behaviour.

Following the initial data gathering procedure where a baseline is established, the experimenter must establish some reinforcement contingencies relevant to the subjects. It is perhaps best to ask the subjects what they find reinforcing, although it is easier to use money, which is the most common generalised reinforcer in our society. The subjects can

then choose whatever primary reinforcers they desire with the monetary reinforcement given, as was done in this study.

Next, it is necessary to specify the final performance desired, or the target behaviours (Gottman and Leiblum, 1974). It is not only necessary to identify the behaviours precisely but also to determine how they are to be measured. One prepares for evaluation at this point in therapy. Proper perceptual-motor behaviours were the targets of this study, and were measured by means of two tests.

Finally, one must induce the actual behaviour change using any combination of the behaviour modification procedures discussed previously. Shaping procedures are the most commonly used, especially in conjunction with other techniques (Gottman and Leiblum, 1974). Many behaviour modification techniques were used to teach the experimental group better perceptual behaviour.

It is essentially the aim gradually to generalise the target behaviours to other situations in the natural environment. Generalisation is easier when carried out in a group because the subjects move in an environment which tends to maintain their newly learned behaviours. As group procedures were used in this study, generalisation was naturally easier to attain.

Maintenance of behaviour is the ultimate aim of the experimenter in any situation, and necessarily involves the subject's environment, in this case the underground working area. Maintenance of the perceptual-motor behaviours involves underground modelling of safe and proper behaviours. The more practice the subjects have, the easier and quicker it is for them to produce the behaviours necessary.

The question of evaluation has long been a difficulty for any therapy in any theoretical framework. In behaviour modification many of the old roadblocks to effective evaluation have been bypassed. Researchers say that one cannot talk in global terms regarding the efficacy of a general

technique. One must define the situation in detail and discuss the effectiveness of the procedures used in that situation. One may not generalise beyond that in the evaluation of behaviour modification, at least not at this point in our knowledge.

7 METHOD ADOPTED FOR THIS STUDY

The information set out in this section is presented in a form following the procedure outlined in the previous chapter. It was gathered following behavioural methodology developed for use with human subjects.

7.1 Subjects

It has been the custom to carry out this type of study on a large number of young children who have learning problems, but it was felt that a study involving adults might further the knowledge in this field, in which it is difficult to find large groups with learning (perceptual-motor) problems.

The subjects used were all Malawian adult male novice labourers. They had never worked on a gold mine before. Two hundred subjects were made available for the tests; one hundred in a control group and one hundred in an experimental group.

The age range was between eighteen and forty-five years for the control group, with an average age of 23,9 years. Only one subject was forty-five and the next closest in age to him was thirty-nine years. For the experimental group, the range was eighteen to thirty-nine years, with an average age of 23,0 years. Statistically, there was no significant difference between the groups for the age variable.

The level of education was noted. In the control group, the number of years of education ranged from zero to eight years, the average being 2,1 years. In the experimental group, it also ranged from zero to eight years, averaging 2,5 years. Statistically, it was found that there was no significant difference between the groups for the education variable.

It must be noted, however, that, although all subjects were Malawians, it still may not have been a completely homogeneous sample. The mines recruit from several different regions of Malawi, each having its own dialect and cultural mores. The Malawians from the north are much different from those of the south (Lombard, personal communication). However, the mines do not differentiate between any of these groups in their data. It was, therefore, impossible for the author to match the subjects more carefully according to ethnic group. To match the groups according to nationality was all that was possible.

7.2 A Behavioural Analysis of the Problem

The group of Malawian mine workers was selected for treatment in this study in preference to labourers from other areas because mine officials have expressed the opinion that, although Malawians seem to be among the more intelligent African labourers on the mines, they are slower to learn the techniques necessary for underground work (van Rensburg, personal communication).

Malawians compare well with other ethnic groups in their results on the mining industry's standard Classification Test Battery (CTB) which is administered to all Africans upon entering the service of a mine for the first time. However, it had been noted that they did not benefit as much from their three-week training period as did other groups. Experienced mine officials have expressed the opinion that the Malawians fully adapt to underground conditions only after six months, whereas most other groups generally adapt in about one month.

Specific problems were identified by mine officials. Malawians seemed to take a rather longer time to learn the language of the mines, Fanakalo. As a result, they could not readily understand the instructions

given them, nor make clear what it was they did not understand.

Their knowledge of what to expect when they went underground was limited. They did not understand even the very rudimentary functions they were to fulfil during the initial period underground, when they should be adapting to the conditions.

They generally only improved slowly their understanding of the work that labourers are to do after the first three-month period. The tools necessary for their work, other than the most elementary for sweeping and lashing (shovelling), were foreign to them. They did not understand how the tools were used nor in what conditions. This is not altogether surprising when their home environment is considered. Clearly they had not learnt the use of tools in their training period.

In addition, they seemed to hurt themselves more often than other groups. The injuries were not usually serious, and generally only involved one man. However, the accidents often necessitated time away from the job.

These problems interested the author. She had been interested in perceptual-motor problems in children and had been making a survey of the research in the area. The behaviours noted in children with learning problems seemed to parallel the problems noted in these adults, especially the slowness in learning and a tendency to injure themselves superficially (Bender, 1956; Johnson and Myklebust, 1967; Kephart, 1971; and Stephens, 1970).

The behaviours which these adults displayed could be attributed to some perceptual-motor dysfunction. Further questioning was necessary. Specific questions were asked about the training courses and infliction of injuries. The answers revealed problems with the training procedures, but more particularly continued to point to perceptual-motor problems in this sample of adults.

Malawians, being from a self-governing country and, in general, physically some distance from European influence, are not normally well acquainted with our way of accomplishing tasks. The Malawians who come to work in South Africa's mining industry are usually peasant farmers from rural areas and are, thus, not used to sophisticated tools and methods of work. Consequently, Fanakalo words for tools mean little to them. They have no prior experience which would help them to retain the information, and no context in which to fit the information.

In addition, Fanakalo is a lingua franca based on the English, Afrikaans, Zulu and Xhosa languages. Since most of the Africans who first worked on the mines were Zulu or Xhosa, or closely related groups, with related languages, they experienced little difficulty in learning Fanakalo. The Malawian dialects are not at all similar to the southern African dialects, and therein lies one of the major difficulties for the Malawians in learning Fanakalo.

The above answers, however, do not make it clear why Malawians should injure themselves more often. It was found that they experienced visual perception difficulties. It seems that Malawians broadly do not perceive their position in space accurately. They would try to stand up in a stope (narrow working place underground in a mine) and crack their heads on the low hangingwall (roof). Even with a hard hat on, this is jolting and uncomfortable. They would also not see a jutting rock and would often bump into it in passing.

They have some difficulty in locomotion underground. They do not seem able to balance in a stooped position, as required in stopes, or to move along without bumping into side walls or tripping over loose rocks.

They often did not estimate accurately the force necessary to do a job. For example, they might attempt picking up a boulder to move it, or kick it, instead of breaking it up with a large hammer. In this way they would hurt themselves.

They also did not know how to conserve energy, and would tackle a job without knowledge of its extent. Then they would be tired before the job was finished. Unusual though it seemed to the author, they would often not follow a rhythmical tempo in doing a job, like lashing, and would tire quickly.

Auditorally, they also seemed to misperceive, or fail to perceive at all, important information in the environment. They would, for example, not hear the number of times a whistle was blown and so would ignore a warning of danger. Auditory perceptual difficulties were also mentioned in regard to the language. The Malawians did, despite the difference in languages, learn Fanakalo words. But they would misperceive a command and do something entirely different from what was asked. Or they would fail to perceive any part of the command, and would do nothing.

The foregoing behavioural analysis clearly showed that the training methods being used were not geared to the needs of the Malawians. It was clear that training would have to include, for them, some actual experience of both the tools and the words in order that it might be effective.

In summary, the analysis also showed motor deficits in the areas of balance, rhythm and strength. It also revealed visual and auditory perceptual dysfunctions.

In addition to the foregoing wide-ranging behavioural analysis, a pre-test was administered to a group of thirty Malawians before the experiment proper, to determine the presence or absence of perceptual-motor problems amongst these people.

The Kohs Blocks Test is one which has been used as a test to detect perceptual abnormalities. It is quick and is easily administered in a group. Buros (1971) says that this test correlates well with the more complex and detailed tests of perceptual ability.

The Pattern Reproduction Test is a variation of this test, and is one of the battery of tests (CTB) administered to all Africans on arrival at a mine for the first time. The subjects are given plastic chips, either all red, all white, or half red and half white. There are no other colours. They must choose from these chips to complete a pattern (they are given the exact chips they will need).

The mines use the results of the test only as an indication of the individual's potential adaptability to training. However, it is possible to see the kinds of mistake made and thus use the test diagnostically. This was done for the group in the pre-test for perceptual difficulties. The subjects taken for testing were the first thirty Malawians arriving on that day, who had never worked on a mine before, as they entered the service of the mine. No other selection other than natural selection was employed.

It was found in the pre-test sample that every subject had some degree of difficulty with the blocks test. Some common mistakes made were to complete the pattern correctly but reverse the colours, or to make a red diagonal line by putting the solid red squares diagonally across the board instead of using the blocks coloured half red and half white.

It must be noted that this test does not specify the nature of the perceptual problem. However, it was used as an additional measure of perceptual involvement in the population. Only generally can it be said that, on the basis of the Pattern Reproduction Test, the subjects did not perceive the stimulus material correctly.

7.3 The Selection of the Subjects for the Study

The information given by mine officials suggested that the great majority of the Malawians showed the perceptual and motor problems described above.

The pre-test described in the foregoing paragraphs confirmed that there was some degree of perceptual difficulty in each subject. On the basis of this information, it was decided that it was not necessary to select the subjects for this study.

Most Malawians were considered to have perceptual-motor difficulties, and hence those coming to the mines for the first time were accepted for the study as they entered the service of the mine. Thus, again, natural selection was employed for determining group composition.

Using the criteria set out above, all but four subjects in each group of one hundred (ninety six per cent) were found in subsequent testing, on the basis of the Pattern Reproduction Test results, to have some degree of perceptual difficulty.

7.4 Target Behaviours

The desired terminal behaviours were then precisely specified. It was found that the behaviours which were the target of this study closely paralleled the targets of the mining industry.

The first aim was that the subjects should be able to speak and understand Fanakalo. Their language ability should allow them to follow instructions quickly, answer questions, and ask questions when a command was not understood. They were to have at least one hundred Fanakalo words in their vocabulary.

Secondly, the subjects were to know the names for the tools they would be using underground. They were to be able to explain in Fanakalo how each tool was to be used. Greater detail is given in the procedural section of this report. In addition, the subjects were to be able to demonstrate how each tool was to be used. There were approximately thirty tools with which the subjects were to become familiar.

The third target involved the jobs the subjects would have to perform

underground during the first three months of their contracts. The jobs which are usually performed include installing supports, barring the hangingwall (roof) and face (sides), sweeping, installing prop barricades, transporting timber, lashing (shovelling), operating scraper bells, building ventilation walls, washing down dust or blasted rock, breaking up large rocks, caring for and storing tools, and assisting in the transport of explosives (Grant, 1970). All subjects do not do all the jobs; each subject has his own particular job depending on the gang to which he is assigned.

Finally, it was considered important that the subjects acquire the physical behaviours necessary to aid in the fastest possible accumulation of perceptual data. In order to learn the language necessary for work needs, not only verbal but also physical imitation was required. Learning to do their jobs efficiently requires a fund of physical behaviours which allows the subjects to move about in cramped and unusual conditions, as well as a conceptual understanding of the job. These physical behaviours were also meant to accelerate the subjects' strength and rhythm in order to start work quickly and continue work, missing as few days as possible.

7.5 Reinforcement Techniques

7.5.1 The Token Economy

Because the subjects were to be dealt with in groups, it was felt that a token economy was the best means of reinforcing them (Skinner, 1969). The most common example of a token economy in daily life is in a factory. A group of employees work in the factory and receive a certain amount of money (reinforcement) for a certain amount of work (desired behaviour).

The token has a clear-cut physical status, and it becomes a powerful generalised reinforcer when exchanged for other primary reinforcers. Money can be made immediately contingent on the desired behaviour or,

as in everyday life, it may be given only after a defined length of time. In addition, i‘ is appropriate to a group, where each group member may find reinforcing something different from every other group member. It is then not necessary to determine exactly the reinforcing contingencies of each group member.

Money is probably the most frequently used token. In this study, money was considered to be the best token because its value would already have been established in adult subjects. They would then be able to trade the tokens for other reinforcers at their own discretion. One cent pieces were used as reinforcers on intermittent schedules of reinforcement.

In addition to the cent pieces, cigarettes were used. A discussion with the African instructors who train these novices revealed that Africans generally find cigarettes greatly reinforcing. Cigarettes are also generalised reinforcers among them because, even if the men do not smoke themselves, they can trade the cigarettes for other reinforcers with the Africans who do smoke.

7.5.2 Schedules of Reinforcement

The schedules of reinforcement which were used were intermittent. The subjects were reinforced on the variable ratio (VR) schedule after an average of three correct responses (VR 3) on the first day of the experimental procedure. The second day a VR 5 schedule was introduced, and the third day a VR 7 schedule was introduced.

7.5.3 Shaping

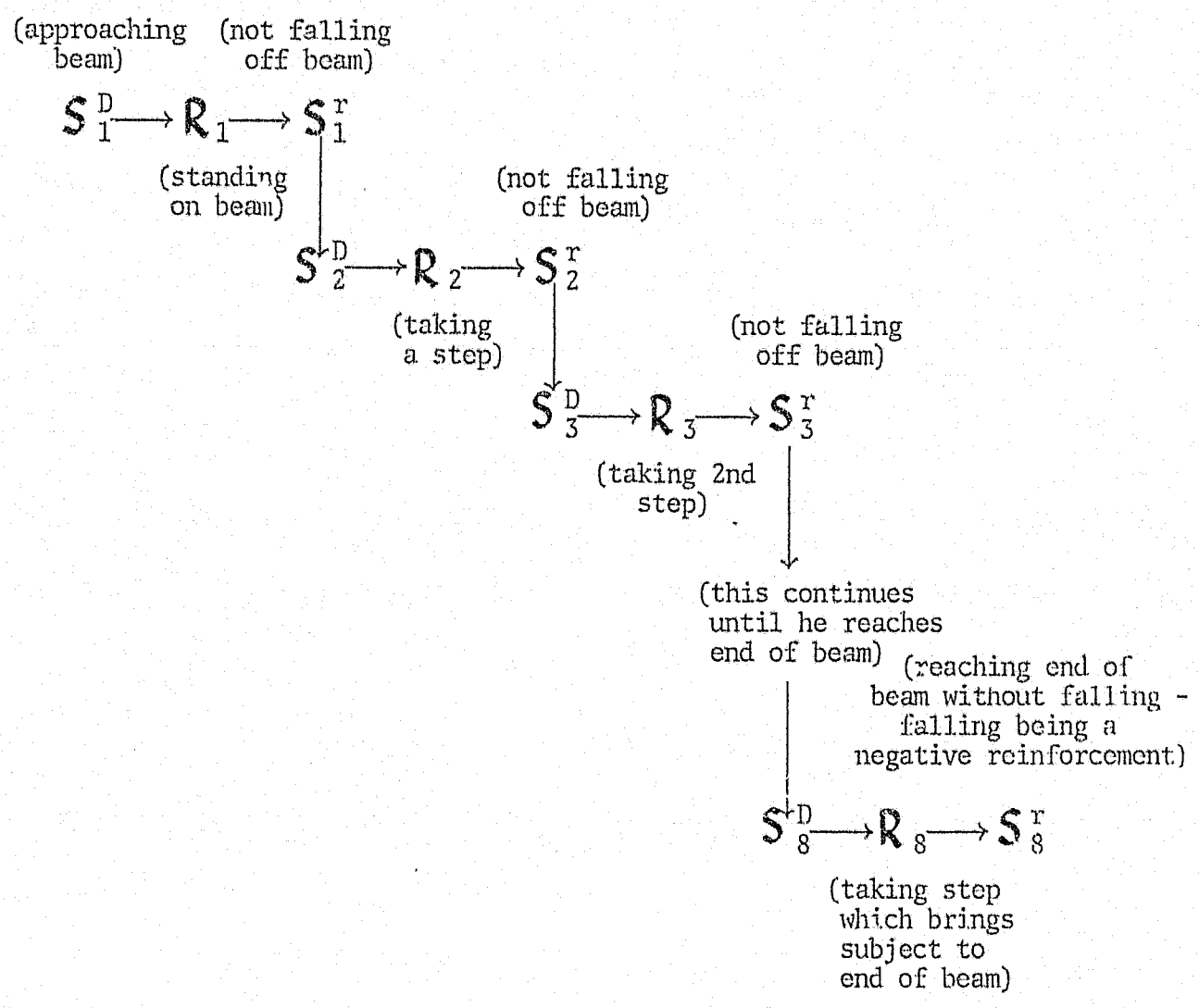
Shaping was employed when necessary with individuals who had difficulty in performing. This was done by using a chaining technique. When the desired behaviour proved too difficult for a subject, that behaviour was analysed and broken down into its component parts. When this was done it was possible for the subject to make and be reinforced for the required

primary response in the chain. After that, the reinforcing consequences become the new stimulus situation for the next link in the chain of behaviours.

7.5.4 Chaining

When using chaining procedures, one need not use reinforcement tokens after each link in the chain. The chain is built up slowly, so that the subject is reinforced first for a very simple requisite behaviour, and then for consecutively more complex behaviours until the subject's behaviour approximates the desired complex behaviour. The final reinforcement becomes far removed from the initial behaviour, which controls the whole chain.

In developing chaining techniques to teach motor exercises, the experimenter constructed the chain so that each performance produced conditions which made possible the next performance. For example, to learn kinetic balance on a 5 centimetre by 10 centimetre by 4 metre wooden beam, the subject first simply stands on the beam until he does not sway or fall off. That becomes the reinforcing occasion on which to take a step forward. Each step is the reinforcing occasion for another until he reaches the end of the beam. That becomes the occasion to try again, possibly with the beam raised off the ground. The diagram overleaf gives one a picture of the process.


(approaching beam)
(not falling off beam)
$S_1^D \longrightarrow R_1 \longrightarrow S_1^r$
(standing on beam)
(not falling off beam)
$S_2^D \longrightarrow R_2 \longrightarrow S_2^r$
(taking a step)
(not falling off beam)
$S_3^D \longrightarrow R_3 \longrightarrow S_3^r$
(taking 2nd step)
(this continues until he reaches end of beam)
(reaching end of beam without falling - falling being a negative reinforcement)
$S_8^D \longrightarrow R_8 \longrightarrow S_8^r$
(taking step which brings subject to end of beam)

The chains of behaviour acquired are developed into more complex chains. First, a chain is developed for a specific behaviour, which involves the motor co-crdination of one part of the body. For example, the subjects slowly learn co-ordination of the upper body, doing exercises in the sitting position. They then generalise those abilities to the kneeling and standing positions. After that they learn more complex behaviours involving co-ordination of the whole body in the standing position. The final aim is for them to move about in a co-ordinated manner in many different situations, to generalise motor co-ordination.

7.5.5 Premack's Principle

It was found very quickly, once the experiment was begun, that it was not necessary to use tokens in the exercise part of the programme. The subjects enjoyed the exercises, and would have done them all day had they been allowed. Therefore, Premack's Principle (Premack, 1959) was put into effect. He states that if behaviour B is more probable than behaviour A, then behaviour A can be made more probable by making behaviour B contingent on it.

Defining the exercises as behaviour B and the Fanakalo lessons as behaviour A, it was decided that it was possible to make the time spent learning Fanakalo more probable by reinforcing it with an exercise period. The exercises were thus exploited for their desirability. The fact that they were developed into chains gave structure to the exercise period. The subjects either worked to better a previous performance of their own, or to better someone else's record behaviour. Generalisation of response was effected in this way.

7.5.6 Modelling

Finally, it must be mentioned that a modelling technique was used. The African instructor had a high status value in the eyes of the novices, and his value as a model was taken into account in this study.

Bandura (1969) cites studies to show that 'instructional control procedures', when used with reinforcement procedures, are extremely effective methods for developing response patterns.

Instructional control procedures can be readily produced by the use of verbal cues administered by a model. As discussed previously, the model instructs a subject to imitate the model's response. Bandura emphasises that this technique is efficacious only when the requisite responses are reinforced. The technique of using a model along with reinforcement consequences greatly increases the speed with which response patterns are acquired.

7.6 Evaluation Procedures

Each subject was tested on the Classification Test Battery (CTB) on his day of arrival at the mine. This test was devised by the National Institute for Personnel Research for the Chamber of Mines of South Africa (Grant, 1970). It is designed to measure the adaptability of the labour force available for work underground on the gold mines, where the intention is prediction of probable performance in a task after adequate training. The CTB has been shown to be affected by age, education, and ethnic group; the differences, however, are too small to be of importance (Lawrence, personal communication). Studies are now being conducted to determine to what extent previous experience with the test affects the results.

The CTB consists of four sub-tests, only the last three of which are considered in the scoring, the first being a practice test. All

instructions are on film so all groups have the same information to start with. Instructions are mimed on the film so no one language group has an advantage.

The subjects view the instructions for the first 'buffer' test, the Coloured Peg Board. They are shown that they must put certain coloured pegs into the same coloured sections of the peg board as quickly as possible. Then they are given a certain amount of time to do the task themselves. This test is fairly simple and the subjects are put at their ease. They also get an idea of what will be expected on the following tests, such as being timed.

The second test is the Pattern Reproduction Test. It is similar to the Kohs Blocks Test, although the patterns used have been developed especially by the National Institute for Personnel Research for the African population. Instead of blocks, the subjects are given chips of only one colour or one colour combination. They are given the exact chips they will need to complete the pattern, but in a random order.

The third test is called the Circles Test. It consists of a number of circular patterns to be copied, and sets of six to eight chips which can be used to make each pattern (total of nine patterns). Only four of the chips are required for each of the circle patterns. The subjects must pick out the correct four from each set of six or eight chips.

The fourth and final test is the Form Series Test. The material consists of a plastic board, on which are printed twenty-two rows of different coloured shapes, with a further twenty-two more complicated patterns on the reverse side of the board, and a box of coloured plastic forms matching the shapes on the board. There are both large and small circles, squares, and triangles, each presented in three colours - red, blue, and yellow. Each series of shapes in each row printed on the board is followed by a blank margin, which must be filled in by the subject to complete the series.

The subject's scores on the three sub-tests of the CTB are added together to get a total score. The maximum possible points for the Pattern Reproduction Test is thirty-nine, for the Circles Test thirty-two, and for the Form Series Test thirty-six. The raw scores are then converted into Dudecs, as follows :

Total Raw Score	Dudec	Job
106-107	1	
100-105	2	(Pink card)
91-99	3	Drivers
79-90	4	
65-78	5	
52-64	6	
40-51	7	(Yellow card)
31-39	8	Construction Workers
23-30	9	
17-22	10	(White card)
14-16	11	General Labourers
1-13	12	

Those subjects who attain a Dudec of from one to six, inclusive, receive a pink card, and after a term of apprenticeship underground become drivers of locomotives and scraper winches. Those whose Dudecs are from seven to nine, inclusive, are given yellow cards and become construction workers, who lay pipes, tracks, rails, and who prepare the tipping points for the ore-bearing cars. With a Dudec of ten, eleven or twelve, the subjects receive a white card and are assigned to general labour underground, such as sweeping, transporting packs, cleaning drains, etc.

Grant (1970) found that the Circles Test requires 'perceptual speed' on the part of the subject. That is, he must sort through a mass of distracting material to find a configuration he has held in mind. Perceptual speed also includes his ability to compare pairs and quickly to accept or reject them as matches. Both the Form Series Test and Pattern Reproduction Test make use of 'conceptual reasoning'. This factor has been defined as the ability to apply a general rule to a problem after distinguishing the given stimuli from each other. It has been noted that this also involves organised perception of the material. Therefore, in general, it can be said that the CTB is a perceptual test, and may be used to measure perceptual ability.

It was felt that the CTB, although useful in that it is automatically administered to all Africans, was somewhat too sophisticated to assess adequately any changes in behaviour that might result from the training programme. A checklist of behaviours that would be necessary underground was therefore developed by the author from the list of target behaviours. This checklist can be found in Appendix A. It was felt to be more appropriate for assessing the results of the programme at the behavioural level, and was administered as a check on the results of the CTB.

Siegel (1954) discusses the relevance of a checklist to real life situations and its reliability. According to him, it is as reliable as any more statistically-based measurement. The checklist was administered to a number of shift bosses, who were chosen by the Assistant Mine Manager. Six shift bosses in charge of each group completed the checklist for their respective group. Thus, the test material consisted of a battery of tests of perceptual ability, the CTB, and a checklist of behavioural change.

8 PROCEDURE

The exact procedures used with each group during the study are set out in this section. First, however, a short resume and comparison of the two groups is given for quick reference. Then the procedure for the control group is presented in its entirety, followed by that for the experimental group.

The procedure used for the control group is the same as is usually used by the mines for training any group of African labourers. The procedure used for training the experimental group was developed by the author, following a behavioural analysis of the situation. The procedure makes use of behaviour modification techniques.

8.1 A Chart for Ease in Comparing the Treatment of Groups

	CONTROL GROUP	EXPERIMENTAL GROUP
DAY 1	Test (CTB)	Test (CTB)
		Test of Co-ordination
	Mime and Actions	Mime and Actions
	1. Sentences re daily life	1. Sentences re daily life
	2. Naming tools in box	2. Naming tools in box
		Gross Physical Exercises
		VR 3 Schedule of Reinforcement
DAY 2	Mime and Drill	Test (Eye Control)
	1. Repeating above	Mime and Actions
	2. Naming tools on wall	1. Names and uses of all tools
		Exercises
		1. Eyes and Eye-Hand Co-ordination
		2. Physical Co-ordination
		Safety Lecture
		VR 5 Schedule of Reinforcement

	CONTROL GROUP	EXPERIMENTAL GROUP
DAY 3	Mime and Drill 1. Naming tools 2. Naming blasting materials Safety Lecture	Exercises 1. Eyes and Eye-Hand Co-ordination 2. Physical Co-ordination New Procedures for learning Fanakalo 1. Obeying commands 2. Singing 3. Without viewing tool, and with only auditory clue, giving its use Safety Lecture VR 7 Schedule of Reinforcement
DAYS 4-5	Lashing Underground to build Strength Possibly learning uses for Tools 'in situ', but with no Preparation	Continue Above Ground Training using Mock-up Stope - some Lashing Review of Safety Practices & Fanakalo Exercises 1. Eyes and Eye-Hand Cor-ordination 2. Physical Co-ordination
DAYS 6-8	Lashing Underground	Lashing Underground
DAYS 9-12	Lashing Underground	Acclimatization
DAYS 13-14	Acclimatization	Acclimatization
DAY 15	Acclimatization	Re-test (CTB)
DAY 16	Acclimatization	On the Job
DAYS 17-18	Acclimatization	On the Job
DAY 19	Re-test (CTB)	On the Job
DAY 20	On the Job	On the Job

8.1.1 Initial Test

During the morning of his first day at the mine, each subject was tested on the Classification Test Battery (CTB). The same four mabalans (African clerks) administered the test to all the subjects, both before and after the different training programmes. The first testing situation, as usual, determined the jobs the men were to perform when posted for underground work.

8.2 Control Group

8.2.1 Day One

The CTB test took the entire morning of the first day, after which the subjects had lunch, and the three-week training programme began. The subjects were trained in groups of about ten to twelve men by an African instructor ("Team Leader").

The target behaviour of primary importance to the miners during training is an ability to speak and understand the lingua franca of the mines, Fanakalo. The need for this was mentioned in section 2.1. The men must be able to follow instructions and ask questions when the instructions are not fully understood. It is also important that the men are able to communicate with each other, irrespective of their home language. The first day the men were taken into a classroom, and the instructor greeted them. He then immediately began saying sentences in Fanakalo and carrying out the action of the sentences, according to a manual for the instruction of Fanakalo. The subjects had to say and do as he did.

The first sentences learned on Day One were: "I am (you are, we are) sitting down. I am standing up. I am walking. This is the door. I am opening the door. I am going out. I am coming in. I am closing the door." They practised this for half an hour.

The instructor then took out a small box with a few small tools in it and again spoke in Fanakalo, showing the men what he was saying. The men had to repeat, in a group and individually, all these sentences as well. These sentences are as follows: "This is a box. This is the cover. I am taking off the cover. I put the cover on the stool. This is a bolt. This is a nut. I am screwing the nut onto the bolt. This is a spanner. I am tightening the nut with the spanner. I am loosening the nut with the spanner. I am unscrewing the nut from the bolt. I am putting the nut in the box. I am putting the bolt in the box. I am putting the spanner in the box. I am putting the cover on the box".

No one was able to say this whole paragraph by the end of the first day. It was noted by the author, however, that out of each group there seemed to be one subject who caught on very quickly, and remembered much without prompting. Three or four did not seem to understand at all. The latter did not repeat fifty per cent of what the instructor said. The other subjects in the class occasionally had difficulty, but, in general, were able to repeat everything.

During the afternoon there was one break, during which the men were shown how to lace and tie their boots correctly, and how to wear their leg protectors and hard hat. They quickly smoked a cigarette, had a drink of water, and then went back into the classroom. The rest of the afternoon was spent repeating the above phrases. More attention was given to individual subjects' repeating the sentences this time. When a subject did not repeat correctly, he was stopped and the next man took his turn. It was felt that the slower subjects got further and further behind, as they seldom had a chance to give the full sentence correctly.

8.2.2 Day Two

The second day was begun as the first was ended, by repeating the above phrases. This lasted for about an hour. Usually by that time at least

one subject, and occasionally two, could repeat the paragraph completely, with no prompting or errors. The other ten subjects had various degrees of trouble with the new language, some needing only occasional promptings, others knowing only a few words.

After an hour the instructor began teaching the subjects the names of the tools required underground. This was done to fulfil the requirements for the second target behaviour. It is important that the recruits know the names of the tools necessary for work underground. The men should also know for what purpose the tools are used and how to use them. However, it seemed to the author that the men did not learn how to use the tools at all. They were simply drilled in the names for the tools. The subjects first repeated, after the instructor, the names for the tools, then, in a group, they gave the names with no prompting; and finally each individual tried to say the names, with no help from the instructor. This took most of the rest of the day.

The sentences they had to repeat were as follows: (See Figure 8.1)

"This is a shovel. This is a chain. This is a bolt with a nut. This is a fish-plate. This is a four-pound hammer. This is a pinch bar. This is a chisel. This is an eye bolt. This is a spanner. This is a shifting spanner. This is the wire for the winch. This is the pipe for water. This is the pipe for air. This is a pick. This is an eight-pound hammer. This is a fourteen-pound hammer. This is a support stick. This is a two by two timber. This is a four by four timber.

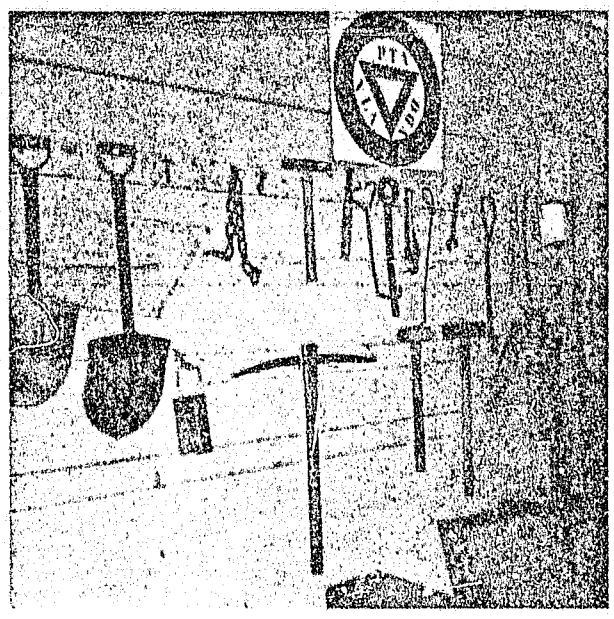


Figure 8.1

This is a wedge. This is a rail spike. This is a rail spike extractor. This is the timber for the track. This is a track. This is a drill. This is a track lifter." It will be noted that imperial measures are still used and not metric units, to avoid confusion in Fanakalo.

During the second day the men had two short breaks for a stretch, a drink of water and a cigarette - one in the morning and one in the afternoon. They also had an hour for lunch. It must be noted here how the Europeans at the training centre cared for the welfare of these new recruits. All the men, including the novices in the training programme, are supposed to go to the compound for their lunch. However, the novices have their lunch delivered to the training centre, where they eat. The European officials believe that the novices have enough to get used to at the mine without getting disoriented in the middle of the training day. Thus, lunch is a real break for them.

8.2.3 Day Three

The subjects continue repeating the above phrases on the third day. Usually the subject who can repeat all the phrases from memory takes over the job of instructor. He asks the other men: "What is this?" while pointing to one of the tools, and they must answer in a group or individually. Again there is a break during the morning, and lunch at the training centre.

The early afternoon was sometimes spent learning about safety underground; however, not all groups received this training. Probably the target behaviour of greatest importance to the mining industry is that the men work safely underground and are not hurt unnecessarily. To achieve that target the instructor showed the men the blasting equipment, told them the names for each piece of equipment, and told them to keep away from it underground and to tell their European miner if they found any blasting materials lying around. [illegible] the lo[illegible]

righthand corner of Figure 8.1 can be seen the box containing loops of the fuses used to light the charge, with the different blasting materials. At the top of the picture is the red and white sign which is present all over the mine to remind the men, in three languages, to Prevent That Accident.

The instructor had the subjects repeat after him: "This is a five minute fuse, this is a fifteen minute fuse, this is a blasting cap, this is exploding powder, this is nitroglycerine". He pointed to the materials in the box as he spoke. The same procedure was followed as before where the men first repeated after him in a group, then responded in a group with no prompting, and then responded individually. They also learned the Fanakalo for "prevent that accident", pointing to the initials as they said the words.

After the second break the subjects generally reviewed what they had learned over three days. They repeated the sentences to do with everyday life, they told about the tools in the box, they named the tools on the wall, and, if they had learned them, they gave the names for the blasting materials.

8.2.4 Days Four to Twelve

The fourth major target behaviour important to the industry is that the recruits develop the strength necessary for strenuous work underground. The men usually come to the mine underweight and physically unfit. To achieve the target, the subjects are fed well at the mine, and, after three days of Fanakalo training, are sent underground to a cool stope (working place) to do lashing (shovelling) of loose rock. Because the men have to lash while in a squat position, this strengthens their leg as well as arm muscles. This continues for nine days.

Another target behaviour is that the subjects practise Fanakalo. Not much new is learned, but at least here they may learn what some of

the tools are for and how to use them. The subjects can only practise what they have already learned above ground, as far as the language is concerned. However, they do get some practical experience.

They put the rock into such a position that it makes a stone ventilation wall. They may learn to sweep carefully, because, after the gold-bearing rock is removed, some gold is still left in the fine rock on the floor and must be collected. They may learn how to break up a large rock so that the pieces may be moved with a shovel. Finally, they may learn to care for the tools they use, by using them properly and putting them back where they belong when the work is finished. In addition, safety lectures are given in Fanakalo during this period and the target behaviour is to achieve safe working by the subjects. All the above behaviours are necessary for work underground and are specified by the industry as target behaviours to be achieved during the training period. Whether any of these behaviours, besides building strength, however, are taught or not, depends on the shift boss in charge of the men in the stope, and the amount of information the subjects have at their disposal after the Fanakalo training sessions.

8.2.5 Days Thirteen to Eighteen

The last week is spent in the acclimatization chamber. This is basically an extension of the attempt to condition the men physically for work. It also conditions men for work in hot areas of the mine. Men who have not been acclimatized are susceptible to heat exhaustion and heat stroke, which can prove fatal. The target behaviour is explicit in this case. The industry wants the men to begin working quickly, but more importantly to be able to work continuously and not to become sick or be affected by heat. Therefore, a great deal of time is spent on strengthening and acclimatizing the men. The acclimatization chamber consists of a large

heat-controlled room containing rows of concrete blocks. The men go into the room wearing only a pair of shorts and stand in front of a block. There is a light in the room which blinks on and off. The men must step up onto the block with both feet, then down again onto the floor in time with the light - a step for each flash. Many variables are taken into consideration. The blocks are of various heights, with a tall, heavy man having a higher block than a short, small man. On Day thirteen (the first day of acclimatization) the room is relatively cool and the light blinks at a fairly slow speed. Both variables are increased in intensity until Day eighteen when the temperature in the chamber is the same as that in the hottest of any working area underground, and the light is blinking quickly.

The physiologists of the Chamber of Mines' Human Sciences Laboratory keep a close watch on this part of the training. Regular checks are made by the staff of the acclimatization section of the men's weight, temperature and blood pressure. If a man cannot keep up with the rest physically, he is taken out and he starts the acclimatization process again from the beginning a few days later. If a man is deemed physically unfit even after the week, he must do as many more days as necessary to become fit. A very few recruits never become acclimatized for various reasons, and they are posted to surface work, as the mines would rather not take chances with the health of the men. Thus, it was felt that the mine met the target behaviour it set for itself in this case.

8.2.6 Day Nineteen

For the purposes of the study, the subjects were given an extra day on surface before beginning work. They were tested the second time on the CTB to give an indication of the degree of improvement which could be expected from the usual training procedures. This again took most of the morning, and the subjects began work underground on Day Twenty.

8.3 Experimental Group

8.3.1 Day One

As for the control group, the first morning was spent in the testing situation. After taking the CTB the experimental subjects also had lunch, and then the training programme began. These subjects were also trained in groups of about ten to twelve.

The target behaviour of first importance was again to learn Fanakalo. The men were greeted in Fanakalo by the instructor when they arrived. Basically the instructor followed the outline set out for him by the manual. However, the author introduced tokens, in the form of one cent pieces and cigarettes. These were issued on a variable ratio schedule. On the first day a VR 3 schedule was followed.

The reinforcement procedure was done on an individual basis, so that when the whole group responded they were not reinforced. Only when an individual subject gave the required number of responses, was reinforcement administered.

During the first half hour of the afternoon the subjects repeated in a group the same sentences as the control group learned regarding daily life; in addition, they had to perform the actions. For example, they stood up when they said: "We are standing up", and they walked when they said: "We are walking", as did the control group. Then, however, during the next half hour, the men were asked individually to say some sentences with no prompting. The first time each subject received reinforcement for whatever he produced. Every subject was able to say at least one sentence in Fanakalo, and carry out the action, even though it may have been a repetition of the one just prior to his.

From then on the VR 3 schedule was used. Between one and five correct responses had to be given before reinforcement was administered. The number of correct responses necessary was determined by a table of random numbers. Reinforcement was given for the required number of responses per subject.

After each subject had received a reinforcement for saying at least one sentence in Fanakalo, the instructor ordered him individually to carry out one of the actions he had just learned. He would say to the first subject: "Stand up". The subject had to stand up and say: "I am standing". He carried on giving various instructions to the same subject until the author reinforced the subject for the required number of responses.

Occasionally some shaping was necessary. It was mentioned previously that some of the control group subjects seemed to get further and further behind because, when they could not remember a sentence, they were passed over. In the experimental group these subjects were not passed over, but rather their behaviour was shaped, using a modelling technique. If they could not repeat a whole sentence at first, they were reinforced for what they did say. Then the next subject was asked to do the same thing. After that subject had given the correct response and had been reinforced, the first subject was asked the same thing again. If he came up with the correct response, he was rewarded by the author. He was also reinforced by the other subjects (to the surprise of the author). When he responded correctly, they smiled, saying: "Yes, good, well done". If he still did not respond correctly, the procedure was followed again; however, this happened very rarely.

That period lasted for forty-five minutes, after which there was a break. However, this break was different from the one the control subjects had. In addition to a drink of water and a cigarette, the subjects participated in special exercises during the break.

The target behaviour was twofold. The exercises helped the men gain strength, which was an explicit target of the mines. However, the exercises were put forward by the author to achieve the target of improving the perceptual-motor behaviour of the subjects. The exercises were intended to enlarge their body of motor information, necessary for perceptual-motor match later underground.

The subjects performed the exercises until they were fairly proficient. It was not necessary that they develop a high degree of skill, but rather that they develop a generalised ability to perform physically in many areas.

Initially the subjects were tested to determine the degree of physical inco-ordination. First they lay down on the grass and were encouraged to relax, according to the techniques of Jacobson (1938). A relaxed attitude of the subjects was found to be achieved quickly. Then, keeping the rest of the body relaxed, each subject was asked to move one part of his body up and down and in and out. The subject lifted each arm individually up and down and then moved it out and in on the grass. Then the same procedure was followed for each leg, while the rest of the body stayed relaxed. Then he lifted his head up and down and turned it from side to side. Next he lifted each shoulder off the ground and moved it gently back to the ground, and, keeping it on the ground, pushed it up toward his ear as far as possible and down again. Finally, keeping his shoulders and back on the ground, he moved his arm down to touch the side of his right knee, then around to the side of his left knee.

This was done to determine quickly the degree to which each subject could differentiate various muscle groups from the rest of his body. It is a variation of one test, from Kephart's Perceptual-Motor Survey (1966), for gross motor differentiation. This test determines the

extent to which a subject can move a single muscle group without involving any other muscle group.

For some subjects this was easy. They had no trouble with differentiation. But usually at least half the subjects had some degree of difficulty and at least one in every group could not move one body part without tensing up the rest of the body. Those subjects were, without fail, the ones who could not readily repeat a sentence in Fanakalo.

When it was determined which subjects had difficulty at this level, a shaping programme of exercises was followed for them, using the chaining techniques. One exercise was given as a model. Those who found the previous differentiation test easy were expected to perform the model exercise the required number of times for a reinforcement. Those who found the previous test difficult also had difficulty with the model exercise. The model exercise was analysed into a chain of behaviours, and reinforcement was administered after each individual behaviour, as necessary. The exercises were adapted from Mosston (1965).

The exercises on this fi[illegible]y included jumping jacks, forward and backward rolls, push ups and sit ups. The sit ups enhance differentiation of the waist. The men who had no difficulty with this exercise were reinforced on the VR 3 schedule by the African instructor, while those who had difficulty were shaped by the author, using the above procedure. First the subject was allowed to use his arms to help pull himself up and was reinforced for this. The subjects then helped each other, holding each other's legs down. Then he had to keep his hands behind his head and use only his stomach muscles to pull himself up to receive reinforcement. When this was mastered all subjects were on the VR 3 schedule.

Push ups enhance differentiation of the arm muscles, and once again a shaping programme was used to help those who had difficulty. The

subjects who found this exercise easy were again reinforced on a VR 3 schedule. The others were first reinforced for pushing up the top half of their bodies. Next they were reinforced for pushing up the whole body, keeping it straight. How they lowered themselves back onto the ground was unimportant. Finally they had to raise themselves fully off the ground and lower themselves, keeping their bodies straight, by bending their arms slowly. The VR 3 schedule was used when this was accomplished.

Forward rolls were easy for all the subjects. The only stipulation for reinforcement was that they did not fall or roll to the side. In order to get reinforcement they had to keep in a straight line. The backward rolls, however, proved quite difficult for a number of subjects. Forward and backward rolls enhance differentiation of neck muscles, shoulder muscles and hip muscles. First the subjects who needed shaping were required to sit with their legs tucked up next to their buttocks and their hands behind their necks. They had to roll backwards quickly, put their hands flat on the ground next to their ears, and touch their feet on the ground above their heads. After that was mastered they had to repeat this, and, in addition, push with their hands so they rocked further backwards. They were rewarded for more and more pushing until they eventually went completely over. They then were reinforced on the VR 3 schedule.

Jumping jacks were felt to be difficult as they involve differentiation. of the arms and legs, so that the limbs can be moved in opposite directions to each other. Most subjects initially found difficulty with this exercise, so a shaping programme was used with all the subjects. First they had to jump - legs out, legs in, out, in - keeping their arms at their sides. Next they stood still and swung their arms straight up above their heads, then down by their sides. The third step was to

swing their arms out as they jumped out with their legs, and then arms and legs in together. The final step was to stand with legs apart and arms at their sides. They swung their arms up and, jumping, brought their legs together, then arms down and legs out. This was practised slowly at first, then more quickly. Finally the VR 3 schedule was used to reinforce the accomplishment of the fast jumping jack movement.

After these exercises the men relaxed with a cigarette and a drink of water for five minutes. It was apparent, from their smiles and animated conversation, that the exercises had been no hardship. In fact, it seemed that they enjoyed themselves and that the exercises were a respite from the Fanakalo training. From then on it was decided to put the Premack Principle (1959) into operation. According to this principle, a preferred task acts as reinforcement for a less preferred task. In this case the exercises became reinforcement for sitting for an hour or more learning Fanakalo. Reinforcement tokens were not used for any but the first group, and then they only received them for that initial forty-five minute period. Shaping the behaviours was still carried on, but the only reinforcement was a nod of the head or a good word from the author or African instructor.

The rest of the afternoon was spent learning Fanakalo. This time the subjects learned the words and sentences for the tools in the small box, the nut, the bolt and spanner. The instructor first went through all the sentences, demonstrating as he went along, and the subjects repeated every sentence after him. He did this only twice. Then the subjects were required to repeat whatever they could remember, and each one was reinforced for whatever he produced. The same procedure was followed as previously.

Then the subjects were called on one at a time to follow an instruction. The instructor would say to one subject: "Open the box".

The subject then had to say everything he was doing, to be reinforced. For example, he would say: "I am standing up. I am walking. I am touching (holding) the box. I am opening the box. I am putting the cover down on the stool. I am walking. I am sitting." An average of three sentences had to be said correctly for reinforcement to follow. Sometimes shaping procedures had to be used when subjects could not follow the instruction. The same procedures were used as before, where another subject was given the instruction and the first subject had to repeat the sentence after this model helper. Since the first and last few sentences were already in his vocabulary, he quickly learned the middle sentences involving the tools.

Thus, this period at the end of the day was a review period. But, for the experimental subjects, everything they learned during the day was integrated and generalised. The sentences they learned were used in many of the actions they carried out and in as many situations as possible. They did not learn each sentence in isolation, as did the control group.

8.3.2 Day Two

The second day was begun by testing the eyes of the subjects. Kephart (1971) places a great deal of emphasis on one's ability to follow a target visually, keeping one's head still but relaxed, thus enhancing one's visual following ability. As an individual develops a body of motor information, he begins to match the perceptual information which he receives, especially through his eyes, to this body of motor information.

Considering that the visual sensory system is the source of most perceptual information and has the most controls, it is also possible that more problems can occur with this sense. Control of the eyes involves the co-ordination of many muscle systems. The eyes are innervated by both voluntary and involuntary muscles; three pairs of muscles must work together in perfect synchrony; and the two systems, the right eye

and the left eye, must be perfectly congruent (Kephart, 1971). If there is some problem with any of these controls, the perceptual-motor match will be distorted. What the eye sees will not match what the individual knows already from his motor information, and he will be confused.

An evaluation of a subject's ability to control his eyes was needed first. The evaluation involved an investigation of his performance in both pursuit and convergence. A broomstick with a colourful sticker at one end was used to test and train the subjects. To test the subject's pursuit ability the target was moved slowly in an arc, about sixty centimetres from the subject, and he had to follow it with his eyes only, keeping his head still. Movement in an arc is important so that the eyes do not have to accommodate to a change in distance at the same time they are following the target.

It was found that practically nine out of ten subjects had difficulty. They tended to move their heads, although they were specifically instructed to keep them still. (The instructors spoke to them in their own language.) Their eye movements were jerky, especially when crossing the mid-line. In about two cases out of ten a greater degree of difficulty was found, where the subjects did not always move their eyes in relation to each other, so that one eye followed the target and the other occasionally wandered off. In addition, these few subjects often tended to lose the target, especially when they were concentrating on keeping their heads still. When they lost the target it was difficult for them to find it again. They had to search around with their eyes. The same procedure was followed in vertical and diagonal arcs, and much the same results were found.

To test convergence, the broomstick was held straight in front of the subject, about sixty centimetres from his face. He was required to watch the sticker as it slowly came closer and closer to his face till it was

touching his nose. Again, most subjects found difficulty with this task. They tended to follow the target with one eye only, while the other one wandered away from the target, especially at the closer distances.

Difficulty with these tasks would have hampered the eventual perceptual-motor match that was one of the target behaviours of this study. Therefore a few minutes of each day were devoted to eye exercises. The instructor was taught to supervise the subjects' eye exercises. He moved the stick slowly in an arc about sixty centimetres from their eyes, and then slowly toward their noses until their eyes could no longer converge. The aim was to move the target as far in any one direction as was easy for the subject to see, and then just a fraction further. In other words, the behaviour was slowly shaped and perfection was not expected immediately.

After the initial eye exercises of the second morning the subjects engaged in a twenty-minute exercise session, playing a ball game. The aim of the ball game was to help them to generalise their ability to move their eyes to follow a target, in conjunction with hand movements. Ball games are a simple means of involving hand-eye co-ordination. The subject had to see the ball as it flew through the air, and match his arm and/or leg movements to that perception. A circle game was played where one subject stood in the middle and tried to intercept and catch the ball as it was passed from one subject to any other subject. The ball was thrown over the head of the one in the centre, to either side, and even between his legs. At first a big, soccer-size ball was used, and as their proficiency developed a smaller tennis ball was introduced. This increased the degree of accuracy necessary in hand-eye co-ordination.

During the game the instructor introduced new words in Fanakalo that were not taught earlier. He would say: "Watch me" or "Catch" whenever he threw the ball, and the subjects would say the same when it was their turn. From then on all the instructions on how to do the exercises were

given in Fanakalo, in addition to being mimed. It is of interest here to note the active role played by the instructor. He often came up with new and useful ideas which were put into practice immediately. This proved to be reinforcing for him and he became more interested in the amount of Fanakalo the subjects learned.

After the game the subjects were laughing and seemed to be more awake than previously. This seemed to make the Fanakalo lessons that followed less tiresome. The short exercise period to begin the day seemed to shape the attitudes of the subjects so that they were generally more positive, and what followed was also seen more positively.

Following that first twenty minutes the subjects went on to learning the Fanakalo names for all the tools necessary underground. This time, however, the tools were not nailed to the wall but were put on the floor where they could be handled (see Figure 8.2). First the instructor simply went through the names for the tools, as presented earlier, with the subjects repeating each one after him. They went through this twice and then the procedure used before was followed again. The subjects, one at a time, had to give the names of any and all the tools they could remember. Whatever they produced was reinforced.

Figure 8.2

Then a VR 5 schedule was followed. The subjects had to give an average of five correct responses in order to receive reinforcement. The instructor asked each subject: "What is that?" and they had to answer him with, for example: "That is a four-pound hammer". This went on for about an hour until each subject knew nearly all the names for the tools. Perfection was not required at this stage. A shaping programme, like that mentioned earlier, was used for the subjects who had difficulty.

After the first group of subjects had had about an hour's practice with these names, the instructor asked: "What is that for?", pointing to the rail spike. Of course, the subjects did not know the words to answer this question, and, furthermore, it was found that they could not even demonstrate what most of the tools were for. One subject would get up, pick up the rail spike, for example, and put it in a most unlikely spot. Another would pick up the chisel and use it as a hammer, and so forth.

It is the author's belief that initially the instructor, knowing that one of the target behaviours was that the subjects learn the use of each tool, was going to show the author that this was unnecessary and a waste of time. When he saw the way the subjects used the tools, he began to show them and tell them in Fanakalo the correct uses. He was also helpful later in thinking up different training procedures, and was a valuable aid in the control of variables.

From that time on the instructor always started teaching the subjects the uses for the tools, with no questions. He picked up each tool, said its name, showed the subjects how to use it, and told them what he was doing, in Fanakalo. The manipulations were as follows.

"This is a shovel. It is to move the stones." He pretended to scrape up a shovelful of stones and threw them in front of him. "This is a chain. It is to pull the winch which clears the rocks from the face." This was

difficult to demonstrate without all the other apparatus so the subjects saw it in action later on in the programme. "This is a nut and bolt. Screw the nut onto the bolt. This is a fish-plate. It connects two pieces of track." Here he put two pieces of track together, put a fish-plate on each side of the join, and bolted the two pieces together with two bolts. "This is a four-pound hammer. It tests the hanging wall (roof in the mine) for loose rock." He gently taps at an imaginary hanging wall to make any loose rock fall now instead of unexpectedly later. "This is a pinch bar. It is also used to test the hanging wall." He pushes the thin end of the long bar into an imaginary crack in the ceiling and tries to pry down any loose slabs of rock. "This is a chisel. It is used to split the timbers to make them the right size for a pack." He picks up the chisel, the four-pound hammer, and the timber; puts the timber on one end; puts the chisel into the top end and pretends to hammer it down the middle, thus splitting the timber lengthwise. "This is an eye-bolt. It is hammered into the hanging wall and many of them together are used to hold pipes and cables." He pretends to hammer it into the ceiling and threads a wire through it and then puts a pipe through it. "This is a spanner. It is used to tighten a bolt." He tightens the bolts which are holding the tracks together. "This is a shifting spanner. It is used to connect pipes." Here he opens the spanner wide and pretends to attach two water pipes, and makes it smaller and pretends to attach two air pipes. "This is wire. It makes the winch work. This is a pipe for water. It is to settle the dust after blasting. This is a pipe for air. It is to cool the men underground." Again, the purposes of these tools were explained later in a mock-up stope above ground, where the men could see the winch in action. "This is a pick. It is used to break loose a big rock from the face." He demonstrates the action necessary for using a pick, from up down, not side to side or pulling up. "This is a

fourteen-pound hammer. It is used to break up big rocks." He brings in a large boulder and pretends to smash it into small pieces with the hammer. "This is a two by two timber. This is a four by four timber. They are used to make support packs." He demonstrates how it is possible to make three different sizes of packs, depending on the size needed. Using only the two by two timbers, the pack would be two feet on each side, stacked in a box shape. With the four by four timbers, it would be four feet square. Using both sizes of timber, it would be a two foot by four foot box. "This is a wedge. It is to wedge the pack tightly against the hanging face. This is an eight-pound hammer. It is to hammer the wedge into the pack." He picks up the wedge and eight-pound hammer and pretends to pound the wedge into a space in one of the packs. "This is a drill. It is used to drill a hole in a rail timber (sleeper). This is a sleeper. Put the track on the sleeper. This is a rail spike. It holds the track to the sleeper." He puts down a sleeper, which is like a four by four timber, but has marks on it indicating where holes should be drilled. He puts the drill onto the marks, puts the chisel through the hole at the top of the drill, and turns the drill, using the chisel for leverage, thus boring the hole. Then he puts the track onto the timber and positions it between the two holes. He puts a spike into each hole and hammers it in with the four-pound hammer, thus securing the track to the timber. "This is a rail spike extractor. It is used to remove the spike." He demonstrates how to lever the spike out of the hole. Then he continues to loosen the bolts and takes them out, strikes the track with the four-pound hammer till the fish-plates fall off, and then hammers the tracks, pretending they have been there a long time, to loosen them from the timbers. "This is a track lifter. It is used to pick up the track." He puts the tool, which is shaped like an L with a little hook at the end, through a hole at the side of the track

and lifts it off the timber, a much easier way to carry a track than with one's hands.

He went through this three times, the subjects repeating each sentence after him. Then each subject had to come up in his turn and say and do whatever he could for as many tools as possible. In this case the subjects were reinforced for whatever they were able to do, even if they were only able to do the action without saying what they were doing in Fanakalo. Every subject, however, managed at least one Fanakalo explanation, although they all knew many actions. After that the VR 5 schedule was put into operation.

The instructor asked a subject: "What is this?" The subject had to answer completely, as follows: "It is a drill. I am standing up. I am walking. I am picking up the drill and the chisel." The subject then put the chisel through the hole at the top of the drill and went over to the track timber. "I am boring a hole in the timber. I have put down the drill and chisel. I am walking. I am sitting down." The subject was reinforced for between one and ten correct sentences, depending on which number came up on the table of random numbers. By this time all the subjects could say part of their required paragraph, like the one preceding, but some could not remember the Fanakalo sentence for the job they did. In that case the instructor would begin the sentence, saying the first word or two, and sometimes the subject could finish the sentence. If he could not, the instructor gave the whole sentence, the subject repeated the sentence, and then repeated the paragraph, including the sentence he could not remember the first time. None of the subjects knew all the words for all the tools so the instructor modelled the behaviour often.

This procedure took an hour and a half. After those first three hours, by about ten o'clock, the subjects were given an exercise break.

The subjects were then told they could "play sport" because they had done so well at learning Fanakalo.

The subjects started out the exercise period doing the exercises they had difficulty with the day before. They practised backward rolls and jumping jacks for ten minutes to increase their differentiation ability. Then they started some balance exercises. Balance is necessary to help maintain a consistent orientation to the gravitational force and thus to maintain a safe and efficient orientation to the environment (Kephart, 1971). The ability to balance in many situations, to generalise the ability, was made a target behaviour because underground the subjects would need to be able to orient themselves to different conditions. For example, underground in the stopes most of the ceilings are only one metre from the ground, and the men must be able to move around in that confined area.

According to Mosston (1965), there are three types of balance: balance in a stable position, balance in motion, and recapturing balance in a stable position after being in motion. All three types of balance were incorporated in the exercises. The first balance exercise involved the balance board. This is a five centimetre by ten centimetre beam, which is about three metres long. It was raised about eight centimetres off the ground and the subjects had to walk along it, forward, backward and sideways, keeping their balance. They were made to walk slowly and not allowed to keep their balance by running. The subjects were encouraged to say: "I am walking" during this exercise. These first exercises were easy and new adaptations were quickly tried.

One subject stood at each end of the plank, they walked toward each other, had to pass each other in the middle, and continued to the opposite end. This was quite difficult for most of them, but when one pair did complete the task they all tried harder to do the same. Here they were encouraged to say: "We are passing".

Again, one subject was at each end, one on hands and knees, one standing. They approached each other and when they met the one standing had to step over the one on hands and knees, and they both continued to their ends.

Each subject, one at a time, had to put his glove in the middle of the plank, then start at one end and walk toward the middle. When he approached his glove, he had to kneel on one knee and bend over to pick up the glove in his teeth. He then had to stand up and continue to the end. The subjects learned to say "kneel" for this exercise.

After these balance board exercises the subjects tried out exercises involving balance in a stable position. They had to stand on one leg, arms up in the air, for a minute, then stand on the other leg. They did a headstand and had to hold the position for thirty seconds. Some subjects needed shaping to perform the headstand. First a partner pushed a subject up into position, the subject resting against the wall of the building. Next he pushed himself up against the building. Then he moved slightly away from the building and pushed himself up. His partner helped him by positioning his legs straight up. Finally he could keep his balance in this position with no help.

They did the seat balance, keeping their balance on their buttocks, with arms and legs up as far off the ground as possible. They also crouched and held their balance for a minute with arms outstretched. Then they crouched and lifted one leg up and stretched it out in front of them, arms out at the sides. This was a difficult position to hold, but they held it for about fifteen seconds.

To balance in the third way, that is, to come to a halt after being in motion and keep one's balance, the subjects took one of their benches outside and used it to jump over. At first they made a running start, jumped the bench, and landed on both feet without bouncing or falling.

The landing was quite difficult. Once their feet touched the ground they had to stay in that position. Practice was felt to be the best way to perfect this type of balance. The bench was long, so two or three could jump at once, and more time was spent in practising the landing. After this was mastered the subjects had to jump over the bench from a standing position and land on the other side, balanced.

After half an hour of exercise the subjects went back to the classroom and practised Fanakalo for another hour and a half until it was time for lunch. They practised the sentences they had learned that morning regarding the tools. Reinforcement went on as before on a VR 5 schedule. Shaping was continued for those few subjects who required it. More and more often it was possible for the subjects themselves to take over the role of shaping the correct responses for each other.

At noon the subjects had lunch at the training centre, which accounted for another reinforcing contingency. They were encouraged to try to speak Fanakalo to each other whenever possible. They did this to some extent during lunch but, as they were on their own, the instructor having to eat at the compound, no control was kept of this. It was really their free time for relaxation.

At one o'clock, after lunch, the men went back to Fanakalo training. The first half hour was spent on a safety lecture. The instructor first taught the subjects the names for a few parts of their bodies and for the equipment they were to use underground. The sentences were as follows.

"This is the head. This is the hand. This is the leg. This is the hat for the head. These are gloves for the hands. These are leg protectors and these are boots for the legs."

Then he proceeded to show the subjects how to wear each article. He showed them which side was the front of the hat and helped them to

adjust it to the correct size. A number of the subjects had been wearing them backwards and so tight that they balanced on the tops of their heads. Then he showed them the proper way of lacing and tying their boots. He then showed them how to buckle their leg protectors so they fitted over the tops of the boots and over the knees. He told the subjects they had to wear this safety equipment at all times underground. He spoke in Fanakalo and tried to demonstrate clearly the problems that could arise if they did not wear their equipment. He explained and showed how a rock could fall and how one could hit one's head and be knocked out if the hard hat was not worn. He did the same to show how one could trip over one's shoe-laces if they were not tied and how one could cut oneself if leg protectors and gloves were not worn (see Figure 8.3).

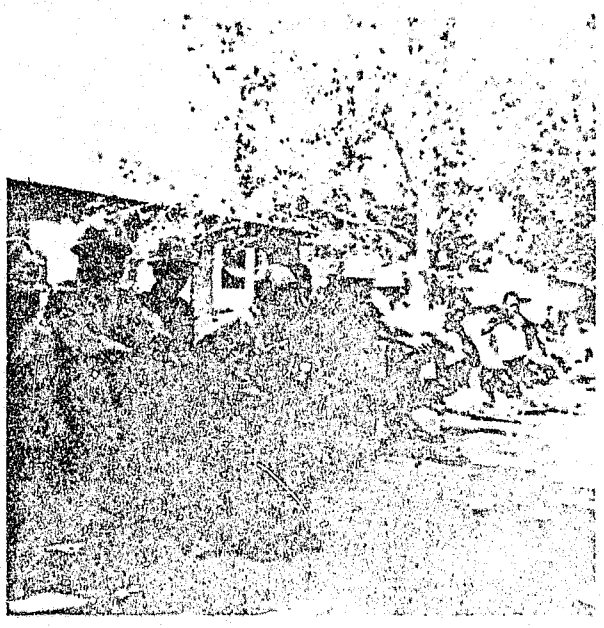


Figure 8.3

After half an hour on that safety lecture, the purpose of which must be obvious, they spent another hour learning the names for the tools and their uses. A VR 5 schedule was used for all the subjects and only very occasional shaping was necessary. The same procedure as before was followed.

After the Panakalo, at about half past two, the subjects went outside for more exercises. They went on with the balance exercises. First a large barrel was brought out and the subjects were required, first, to balance on it, and then to walk backward on it, causing it to roll. The subjects found it easier to walk backward. After that was mastered, by some of the subjects, they tried walking forward. They had to do this with their boots on. These boots have metal studs in the soles, and, having these metal studs in contact with the metal barrel, they had to contend with the slippery and rolling barrel in keeping their balance.

They then went back to the balance beam. This time they walked along the five centimetre side and had to keep their balance. First, with one subject at each end to hold the beam still, each subject walked forward, backward and sideways on the beam. Again, they had to walk slowly. Then the beam was raised about thirty centimetres off the ground and they carried out the same procedures. This was difficult with their boots on, but all the subjects managed it.

Next the subjects tried hopping along the five centimetre side of the beam on one foot, then the other foot. They did not all make it all the way across but they all made it half-way, at least. The most difficult feat was to walk to the centre of the beam, raise one leg, and bend the other leg so that the subject was squatting on one leg, arms out to the sides. Then he had to raise himself up again, without using his arms to push himself up. The author was amazed at the number of subjects who were able to perform this balancing feat. However, it was more important that the subjects learned to balance in many situations, not just to be proficient in one. So some degree of balance was required for each of the above exercises, and the subjects were shaped if necessary.

To finish off this set of exercises the subjects used a ladder instead of a beam. First they had to step quickly into each space on the ground

between the rungs, not missing a space, forward and backward. Then they had to step on each rung of the ladder with their toes, trying to balance only on that rung. Finally the ladder was raised about thirty centimetres off the ground and the subjects had to balance on their toes on each rung all the way across.

After these exercises the subjects went in for their last hour of Fanakalo. Before beginning, however, one subject showed the instructor a sore on his leg caused by the rubbing of his boot on his leg during the exercises. His wound was dressed and then another subject displayed his wound. It was noted that the subjects were issued with rubber and not leather boots, as in the past. The leather boots could be softened but, as this was not possible with the rubber ones, they would always chafe.

It was suggested to the management that socks be issued with these rubber boots so that sores would not develop, especially in underground conditions. The subjects had never developed sores above ground before because they only sat in the classrooms and learned Fanakalo, with no undue exertion. However, when they went underground they did develop this boot rub, which can be dangerous because the sores can become infected. Hospitalisation has sometimes been necessary. If the mine did not supply socks, at least the subjects realised before they went underground that they would need some protection, even if only a few rags tied around their ankles.

This seemed a good point at which to introduce another short safety lecture. The instructor explained what might happen if sores which developed underground were not cleaned and dressed immediately. He told them in simple Fanakalo sentences, and demonstrated without words, how the sore could grow larger and larger, become very painful, and could result in a subject having to go to hospital.

This was an impromptu safety lecture for the first group, but became an integral part of the programme after that. It only took ten minutes and was a new addition to the safety programme.

After this the subjects went back to learning Fanakalo. They had improved by this time but they did not all know all the names and uses for the tools. Usually two subjects in each group, however, knew all the new sentences. These two then became assistant instructors and they asked the others: "What is this? What are you doing?" These two were known to the other subjects, and sometimes those who appeared to be afraid of the instructor (they could not answer his questions) fared better with their friends acting as instructors.

A new technique for the last part of the day was to throw a bean-bag or ball to a subject instead of pointing to him when he was to answer a question. This seemed to keep the attention of the subjects, especially when they were tired at that time of day. It was also an eye exercise involving eye-hand co-ordination. Otherwise the same procedure was followed as before.

8.3.3 Day Three

The third day was begun as was the second, except that the subjects did not need their eyes tested. They did ten minutes of eye exercises, about one minute per subject. The instructor was in charge. They had to follow a target with their eyes to the right, to the left, up, down, in diagonal lines, and as it came toward the nose. This tended to strengthen the muscles.

After that they went outside to play a modified football game. The subjects formed two sides, jumped for the ball, and whichever side caught it had to pass the ball to their goal to score. The subject with the ball could not run, so that maximum eye-hand co-ordination was achieved.

Interceptions were encouraged. The knowledge that the score was being kept by the instructor acted as reinforcement. These games then used what strength the subjects' eye muscles had gained in the exercises and generalised the abilities the subjects were developing.

Following that first half hour, the subjects went back to learning Fanakalo. This time the instructor had a new idea for teaching the subjects the names and uses of the tools. They all had to turn around on their benches and face the back wall, not the tools. Then the instructor would say: "I am holding a shifting spanner. What does it do?" Each subject had a different question to answer involving a different tool. This technique proved quite valuable and took the subjects, and the author, by surprise. The subjects at first found it very difficult. They had to picture the tool in their minds before being able to give its use. Therefore they had to be absolutely sure of the names of the tools in the first place.

As this was so difficult, the subjects were reinforced for every correct answer during the first ten minutes. Those subjects who could not give an answer were allowed to hold the tool behind their backs and feel what it was. Usually they could give an answer from that clue. If they still could not answer correctly, the instructor or another subject would begin the sentence and the subject would always be able to complete it. After the first ten minutes a VR 7 schedule was followed. The continuous reinforcement was only practised for a short time to encourage the subjects to respond quickly to new stimuli.

The schedules of reinforcement were changed every day, necessitating more and more responses per reinforcement, so that the tokens could be gradually phased out and social reinforcers could be used instead. It was felt that if this programme were to be put into practice at the mine, the authorities would not want to reinforce the men with money or

cigarettes in addition to their pay. (Therefore, social reinforcement was instituted on Days Four and Five, to note the subjects' reaction to it.)

The subjects continued learning Fanakalo in this new way for an hour. After that they turned around to face the front of the room again and the instructor began to give instructions to the subjects. These instructions involved using the tools. All the words used were familiar to the subjects, they were just arranged in different order, in the form of a command. The commands were of three varieties. Either the subject had to pick up a tool or he had to use it as directed, or he had to give it to someone. The commands were as follows.

"Pick up the shovel. Pick up the spanner" and so forth for each tool.

"Break the boulder. Test the hanging wall. Bore a hole" and so forth for each tool.

"Give me the four-pound hammer. Find the pick for Joao. Give him the wedge" and so forth for each tool.

The commands were given in a random order. First a subject might be asked to pick up something, then another subject might be asked to give something to another, then another had to pick up a tool, and a fourth had to break a boulder. The subjects had to say in Fanakalo what they were doing in carrying out the command. They had to explain completely, as previously, for example: "I am standing up. I am walking. I am stopping. I am picking up the spanner. I am putting down the spanner. I am walking. I am stopping. I am turning around. I am sitting down." This continued for another hour, after which there were more exercises.

On the third day the exercises were especially selected in order to enhance the subjects' distance perception. This involves an integration of locomotion toward an object and the perception of it, so that one can eventually move around easily in one's environment without the need for

a lot of time-consuming physical testing. For example, through locomotion one learns to run up and down stairs without having to watch one's feet all the time or having to hold onto the railing.

Many other of the exercises involved the use of an ordinary broomstick. Two subjects held a stick at each end, keeping it at various heights from the ground. The height varied from fifteen to sixty centimetres. The other subjects had to begin walking toward the bar from about five paces away and then step over the bar, keeping in stride. They were not to do a little hop before walking over the bar or take an extra large step. They were to walk as naturally as possible. Then the bar was held up higher, from about 120 to 150 centimetres off the ground, and the subjects were required to walk under it, again without changing stride. The stick was laid on the ground and a subject held it at one end, sliding the other end back and forth on the ground. The other subjects had to jump over it as it moved.

Then, with the stick flat on the ground, the subjects jumped forward over it, and then backward over it to their original position. They did this at least ten times, two subjects jumping simultaneously. Even more difficult was to jump forward over the stick, turn 180 degrees in the air, and land facing the opposite direction. As this is quite difficult, shaping was introduced. Instead of jumping over the stick, the subjects first tried jumping over a chalk line. They could not get hurt this way and they practised until they could land on the other side with plenty of space to spare. They then jumped over the bar perfectly with a safety margin on either side.

Another difficult exercise with the stick was to jump so that one foot was in front of the stick and one behind, and then to jump again, changing foot positions so that the one at the back came to the front and the one in front went backward. They had to continue quickly,

alternating the positions of the feet in relation to the stick. To shape that behaviour, the chalk mark was also used in place of the bar, and the subjects could stop between each jump. They had to jump faster each time, though.

After that circles were drawn with chalk on the pavement, and numbered. They were not drawn in a line but were instead in no order at all. They were just close enough so that the subjects could step from one to another. They had to move from circle to circle, stepping on consecutive numbers, without stepping on the circle itself. This was rather like an obstacle course. A variation of this was to hop on one foot from circle to circle. This required balance as well.

After these exercises the subjects returned to the classroom for two more hours of Fanakalo. During this time they learned completely new sentences necessary for social communication. The instructor asked them: "What is your name?" They did not understand so he said: "My name is Ernest." Then each subject repeated after him: "My name is .....", replacing Ernest with his own name. Next the instructor asked: "What is your number?", and he pointed to the number of the wristband of each subject. When the subject merely read off his number as an answer to the question, the instructor would ask again, and, if necessary, give the answer: "My number is ...." The instructor was adamant that the subjects use all the information they had.

The next question he asked was: "Where are you from?" He said: "I am from Limbe" and again asked: "Where are you from?" Each subject repeated the sentence, filling in the name of his village. Finally the instructor asked: "When is your birthday?" He answered: "My birthday is 12th September. When is your birthday?" Each subject had to say: "My birthday is .....", filling in his own date. The subjects enjoyed learning these new sentences. They picked up these sentences quickly

and very seldom needed any prompting. The VR 7 schedule was used again. After the subjects could answer the instructor's questions easily, they were encouraged to make conversation amongst themselves. The subjects paired off, and one subject asked the other one: "What is your name?" The other subject had to answer the question and then ask a question of his own, whichever one he chose. Reinforcement was more difficult in this task. However, as closely as was possible the subjects were reinforced on a VR 7 schedule. The instructor and the author each had about six pairs of subjects to reinforce.

This lasted until lunch time. After lunch, as the author was approaching the classroom, there were sounds of singing coming from that direction. At the classroom it was seen that all the subjects were singing in Fanakalo. The instructor had come back from lunch early and had taught the subjects two songs in Fanakalo - in four-part harmony. The words were very simple but the effect was beautiful. The author had taken a tamborine to the mine, as part of the equipment to be used for rhythm exercises, and the instructor was using it to keep the subjects in time. It was not necessary, but he enjoyed the conductor role. That day the tamborine was given to the instructor as reinforcement for thinking up this new and interesting way of teaching Fanakalo.

The words of the songs were somewhat as follows. They were only two lines each, repeated over and over.

"We have left our home in Malawi
To come to the mine to work."
"We are learning to do it like this (Fanakalo)
We are speaking Fanakalo."

Any number of songs could be made up to do with the little things they were learning daily. It must be noted that to come back from lunch and hear this singing was most reinforcing for the author.

The singing went on for about fifteen minutes. After that the men went on to practising the names and uses for the tools. One at a time, the subjects went through the complete series of tools, giving the names and uses for each tool. Nearly all the subjects could carry out this task without help. Only about two subjects in each group needed any prompting. This help was always given by a fellow subject and consisted of a word or two to help him over the trouble spot. The VR 7 schedule was still followed. This usually took one and a half to two hours, after which time there was a break for exercises.

So far the exercises that the subjects had done were to aid in the generalisation of differentiation, balance and posture, and distance perception. The eye exercises were done to strengthen the eye muscles and the ball games were to continue in the generalisation of depth perception through eye-hand co-ordination. On the afternoon of the third day the exercises were designed to aid in the generalisation of receipt and propulsion. In order to learn to cope with movements toward oneself - receipt - the subjects played a game of tag. One subject was "it", and all the others had to run from one safe goal to another. The first one to be tagged then became "it", and had to catch any one of the others. This game was also played using a large ball. The subject who was "it" had to throw the ball at another subject to tag him. A quick game of catch was always played, too. The subjects used a small tennis ball and threw it to one another quickly, as though it were a hot potato. At first they were allowed to catch it with two hands and then with only one hand.

To learn to cope with movements away from oneself, the subjects had to run a race kicking a ball in front of them. Two large balls were needed for this race, one for each side of six subjects. They lined up at one fence and the first two subjects proceeded as quickly as possible

to the other fence, kicking the ball in front of them as they went, but controlling it. They did the same thing back again and then the next two subjects kicked the ball up and back. The excitement ran quite high as the teams vied for first place. Because this race was received so well other races were included. The subjects again formed sides and used the stick to hit the ball to the opposite goal and then back again. In another exercise the subjects formed groups of two, both men being about the same size, faced each other and pushed against each other with their arms and then lay on the grass and pushed against each other with their legs. Then they sat back to back and pushed against each other with their backs, shoulders and heads.

After these exercises the subjects went back to the classroom for more Fanakalo. There was a safety lecture during this period where the subjects learned about the blasting material in the glass case. They learned the same sentences as the control group. They also learned the safety slogan, "Prevent That Accident". Then, to help the subjects understand what they had just learned, a demonstration blast was organised. Blasting caps that do not explode underground are collected and some of these were used to give the men an idea of what happens when a fuse is lit. Everyone went into the field near the training centre. Two instructors took the caps and a long fuse far way from the rest of us. They followed all the safety precautions, explaining to the subjects what they were doing, that is, taking a fuse that was long enough to allow them to get away, and using a red flag to show anyone in the area that it was dangerous. A few minutes after the instructors lit the fuse and walked away, the caps exploded and a cloud of smoke appeared. The subjects were afraid, but they all stood their ground and did not run. They had been told not to run. Then we all walked back to the classroom. The subjects were all talking among themselves about the explosion. It had made quite an impact.

In the classroom the instructor went over the names for the blasting equipment again while the subjects repeated the names after him. Then he brought out two safety posters and showed them to the subjects. These explained how the caps were used underground and what to do if one found an unexploded cap. The men were told to leave it alone and tell their ganger. That concluded the third day.

8.3.4 Day Four

It had been decided to increase the length of the above-ground training for two days, to give the subjects a better understanding of Fanakalo. They began the fourth day with eye exercises again. The instructor was in charge of the ten-minute session. Then they went outside to play a ball game. They started playing the pseudo-football game, usually without being told.

After their morning exercises, a totally new task was introduced. It was not wished that the experimental subjects should miss out on any essential training underground. It was fortunate, therefore, that there was a mock-up of an underground stope built above ground at the training centre. This stope was used mainly to train African team leaders in various fields, but it was put at the disposal of the experimental group for this study. The subjects did not interrupt any of the normal routine activities.

The morning of the fourth day we all went "down" the mine, into the mock-up stope, whereas the control group on this day went to an underground stope. The instructor took the subjects to the waiting area and explained to them that once they were down in the mine they would come to an area like that. They were to wait in that area until someone came to check their numbers (roll-call) and tell them where to go. The instructor then opened the doors into the stope itself and took the the subjects through.

In the stope, which was about eighty centimetres high and at a dip of thirty degrees to the horizontal, they were shown the ventilation walls made from stones shovelled into piles. Then, along the hanging wall (roof) of the stope, was a wire. The instructor told the subjects what this was for. At one end was a loud whistle, at the other was a man working the winch. When the winch was about to be put into action, the man would signal, and everyone would know that they were to get out of the way. When he was finished he would make a different signal and the others could go back to what they were doing.

The men then followed the wire, which was hanging from eyelets attached to the hanging wall, to where the man was working with the winch. He was teaching other men how to use it, so it was not any trouble for him to demonstrate to the subjects how it worked. They saw the big wire cable for which they had previously learned the name, and saw how it was attached to a scraper which cleared the gold-bearing ore into rail cars. The operator signalled that he was going to start the winch and then put it into operation. The subjects were interested in this and the instructor told them that someday perhaps some of them would have the job of winch operator, depending on their test scores and their work underground.

Next they were introduced to the locomotive. Some men were also learning to become locomotive drivers and the subjects watched them. They were told that when they heard the hooter or siren of the locomotive they were to move as far as possible to the side, away from the track. The locomotive would go past, discharging smoke from its diesel engine. Some of the men were afraid but they did as ordered and did not run away. The locomotive would then go backwards, with another hoot, and the subjects could cross the track.

After the subjects had seen these machines in action they went to work themselves. They began lashing and building a ventilation wall. They started eagerly, but quickly became tired and slowed down. Soon they found their own working pace. Dust was created by this lashing and the subjects saw how the water pipes were connected to hoses and used to dampen down the dust so they could get on with their work in comfort.

The subjects continued with this all morning until lunch time. They were very tired by that time and needed the lunch break. That lasted an hour, and after lunch, once again the author returned to the sound of their singing.

After lunch the subjects returned to learning Fanakalo. The instructor reviewed with them what they had seen during the morning. He talked about the signals given by the winch driver to warn of the starting and stopping of the machine. He reminded them of the behaviour appropriate for each signal. Then he talked about the locomotive and what to do when it came past. He once again brought out the safety posters and showed them to the subjects, explaining the blasting procedures and the behaviours necessary for those conditions. The subjects did not learn to say many of the words. The words they did learn were: "Stop", when they heard the signal for the winch or locomotive, and "Start", when they heard the other signal. They again repeated the names for the blasting equipment.

After this review they went back to revising the names and uses for the tools. By this time all the subjects knew the names for all the tools and understood all the uses. They had rounded off their knowledge that morning when they saw the more complicated tools in operation. Occasionally even the quickest subjects could not remember a word, but that was not considered to be important. Usually another subject would

do the prompting. It was left to the instructor to oversee the subjects; he did not need to teach them.

Following the review the subjects went outside for their physical exercise break. The afternoon of the fourth day was spent on exercises which increased their strength and/or involved the control of the fine muscles. To increase their strength, the subjects climbed a water tower at the training centre, using only their arms and hands. They put on their gloves so as not to cut their hands on the steel braces. Then they pulled themselves up using only the strength of their arms. Some subjects found this very difficult, and, as a shaping procedure, were encouraged first just to pull themselves up and then hang down again, like a pull-up. They did not necessarily have to progress any higher.

To develop further the strength of their arms and shoulders, the subjects had races in various positions. One race was in the "crab" position. The subjects got onto their feet and hands, their backs facing the ground, and "crab walked" forward to a goal and back again. Then the next team-mate did the same. They also did the "body drag" in teams. Again with their backs toward the ground, they held themselves up on their hands only and pulled themselves forward with their arms, their legs dragging behind.

To develop the strength of the lower back and hip girdle, the subjects lay on their backs and, holding a large ball between their feet, raised their legs far off the ground. At first they were allowed to use their arms to press against the ground, and later were required to keep their hands behind their heads. In addition, they sat up in the L position, legs straight out in front, arms slightly back to support themselves, and chest out. From that position they had to raise their legs to a forty-five degree angle, move them slowly from side to side and then lower them. From the same position they raised their legs and made circles in the air, as many as possible, and then slowly lowered them.

In pairs, the subjects took turns pushing each other up, using their legs. One of the pair lay on his back, thighs against his stomach and feet up. The other sat on the first subject's feet and was pushed up by him. The one lying down had to use the strength of his legs, while the one on top had to keep his balance.

The instructor had, all along, shown an interest in the book by Mosston (1965). He was picking out many of the exercises for the subjects after he was told what was required. He was good at thinking up variations of the exercises in the book, too. Mosston always suggests some variations and asks if the reader can think of any others. It was felt that if the instructor had a book of his own he could continue the programme of exercises after the study had been completed, so the book was given to him toward the end of the programme, as reinforcement for his help in the study and to encourage the continuation of the exercises.

No mention has been made of reinforcement on this day. The subjects were only socially reinforced during the last two days. It had been noted that in the control group the subjects were not only not reinforced but also often punished for not knowing an answer to a question. The instructor would criticise the subject who did not understand his instructions quickly enough and took for granted the subject who did learn quickly. It was rather difficult, but the author tried to change this behaviour. At first the author reinforced the subjects for correct behaviours, and then she reinforced the instructor whenever he reinforced a subject so that a chain was set up. Thus, the instructor began to reinforce the subjects for the behaviours he desired. It was not possible to predetermine a schedule of social reinforcement to be followed by the instructor. However, the author attempted to continue with the VR 7 schedule of the previous day, changing the reinforcement only.

Following the exercises the subjects finished the day off by speaking Fanakalo, and the above reinforcement procedure was put into effect. They basically reviewed the names and uses of the tools. First the instructor asked them questions regarding the names of the tools and each subject answered enough questions for a reinforcement. Secondly they were asked questions regarding the uses for the tools. Then the subjects, one at a time, went to the front of the class and named each tool, picked it up and demonstrated its use, telling the others in Fanakalo what he was doing. He did this for from one to fourteen tools, depending on the number necessary for reinforcement. This concluded the activities for Day Four.

8.3.5 Day Five

The fifth day was the last day the experimental subjects received training above ground. They first did some eye exercises and played a ball game, which aided them in eye-hand co-ordination and in contact. This last day the subjects were allowed to play any one of the ball games they had played previously. Most often they chose to play the modified football game.

After the morning exercises the subjects went back to the mock-up stope and received another safety lecture. They were told basically the same thing as they had learned the day before regarding where to wait once down the mine and about giving their numbers to the ganger. Then they were reminded about keeping their safety equipment, hard hat, boots, leg protectors and gloves securely in place. The instructor also reminded the subjects to listen for the signals from the winch and locomotive drivers. He repeated the signals and their meanings. He then advised the subjects as to the best way to lash. He demonstrated how some of them had tried to work too fast and how they had tried to lash in

awkward positions. He showed them instead a more comfortable and efficient position and demonstrated a steady pace for lashing.

After the safety lecture the subjects went back to lashing, as they had the day before. They followed the instructor's advice and did more lashing the second morning than accomplished on the first. The second morning left them less tired as well. Lunch followed the lashing period.

On the afternoon of the fifth day the subjects spent more time doing exercises than on previous afternoons. The exercises were designed to build strength in the subjects, and at the same time were a reinforcement for the week's work. Pictures had been taken at the beginning of the week and were developed by the fifth day. They were also used as reinforcement, both for the subjects and the instructor. They all enjoyed seeing themselves in the various activities of the programme (see Figures 8.4 and 8.5, for example).

Figure 8.4

Figure 8.5

After lunch the subjects participated in exercises to develop strength. There was a low, but very long, step up from the concrete in front of the classroom to the grassed area. The men stepped up with both feet, one

at a time, then down again. They had to do this in rhythm. The tempo they started at first was fairly slow but gradually increased. Some subjects found this very difficult and they were allowed to step at half the speed of the others to begin with. Gradually they were all able to step up and down fairly quickly.

They then had to jump from their feet to their hands and back again, continuously. Again they did this in rhythm, first slowly and gradually increasing in tempo. This exercise was not intended to be done very quickly. What was more important was the springing motion as the subjects jumped from hands to feet and back again.

Then the subjects split into pairs of fairly equal size and weight. They sat facing each other, the feet of one against the feet of the other, and holding hands. One subject rocked back and pulled the other one up off the ground. He was then lowered gently and he pulled up the first one. When the subjects had mastered this exercise, a pair looked like a rocking horse. However, not all pairs did that well.

To finish this set of exercises, the subjects participated in a wheelbarrow race. They formed two sides and again paired off. One member of the pair assumed a push-up position, while the other picked up the legs of the first member. The first member went as quickly as possible on his hands to a goal and back with the second member holding his legs. The race was finished when every member of each side had had a chance to be both the one to walk on his hands and the one to hold the other's legs.

The subjects went into the classrooms following those exercises and finished off their week of Fanakalo training. They generally reviewed what they had learned during the week, and were reinforced socially on a VR 7 schedule, as far as was possible. From one to eighteen correct responses were necessary for reinforcement. The instructor was also

reinforced socially, when he reinforced the subjects, on a VR 3 schedule.

First the subjects paired off and greeted each other and asked from where the other subject came. That subject replied and asked the number of the first. He replied to that and asked the second when his birthday was. Again, there was a reply and the second asked for a description of the name and use of a tool. The members of the pair alternated in asking and answering questions regarding the name and purpose of a certain tool. It was left to the instructor and author only to reinforce correct responses. The subjects enjoyed taking over the role of instructor for another of their fellows.

Following this hour and a half of review the instructor told the subjects that it was their last day above ground. He explained that the next day they would go underground to lash and practise their Fanakalo. They would receive more safety lectures as well. This, he said, would only last for three days, after which they would begin acclimatisation. After that, which could last for one to two weeks, they would begin work underground.

The subjects then went outside for their final exercise period. They again did the stepping exercise they had done just previously. The slower subjects improved a great deal and everyone was able to step up and down very quickly.

The subjects did push-ups after this. Although they had not done any push-ups since the first day, all of them showed improvement in their ability to do them. They had gained strength in their arms during the week. They each did twenty push-ups.

They then lay on their backs, hands behind their heads, and lifted their legs up, holding for a count of ten. Then, one at a time, a subject held a large ball between his ankles and also lifted that off the ground twice, for a count of ten each time.

Finally the subjects high jumped. A length of hosepipe was used as a bar, with a subject holding each end. They started jumping over a height of about sixty centimetres and the bar was raised about ten centimetres at a time. They enjoyed this exercise and it was a good way to end the special programme.

8.3.6 Days Six, Seven and Eight

Three days were spent underground, where the men lashed in a cool stope, practising Fanakalo and having further safety lectures. It was felt that three days would be sufficient, since the subjects had been building up their strength from the very first day. (The control group only started work that would strengthen them on the fourth day, when they went underground.) Therefore, although the Fanakalo training period was increased by two days, the underground period was decreased by six days.

Another of the target behaviours of the mine is to have the new recruits begin effective work as soon as possible. The control group took an extra four days to prepare for work. Over a year with an intake of possibly 2 000 new recruits, that would cost the mine 8 000 days' work.

The stipulation was made that if the shift boss underground in charge of the training stope felt that any subject from the experimental group needed more than the suggested three days, that subject would stay for the full nine-day period. However, this was never required. All the experimental subjects went into the acclimatisation chamber training after only three days underground.

8.3.7 Days Nine to Fourteen

The last week was spent in the acclimatisation chamber, as for the control group. This period is carefully controlled by the acclimatisation staff, with frequent follow-ups by the Chamber of Mines Human Sciences Laboratory to ensure that the men are physically adapted to conditions underground

before they commence work there. The acclimatisation training was not changed and went on exactly as it had for the control group.

After acclimatisation and before going underground to begin work, the experimental subjects were retested on the fifteenth day on the CTB. These subjects commenced work underground on Day Sixteen.

9 RESULTS

The two groups of subjects were compared on the Classification Test Battery (CTB), and on a checklist drawn up by the author. The results of these tests are detailed below. In addition, a check was made that the two groups were comparable on the variables of age and education.

Some graphs indicating the rates of reinforcement and of learning are also given in this section.

9.1 Results of CTB

The results of the CTB and other factors were compared by means of histograms. These allow one to get a quick visual picture of the results. It was noted that the distribution of many of the variables was not normal when viewing the histograms. Ten variables were looked at in relation to the CTB. They were, for each group :

1 Education

2 Age

Pre-test:

3 Dudec

4 Pattern Reproduction Test

5 Circles Test

6 Form Series Test

Post-test:

7 Dudec

8 Pattern Reproduction Test

9 Circles Test

10 Form Series Test

The graphic results are depicted in Figures 9.1, 9.2 and 9.3.

(Note: All the graphs are grouped together at the end of this section.)

Statistical procedures were then applied for each variable to test the null hypotheses that the means of the two groups were not the same, at the 0,05 level.

For the first variable, that of education, the slight differences observed between the means of the two groups were not significantly different (z=1,19). Then all those subjects with no education were removed from the sample and the means of the remaining subjects in the two groups were checked. Again no significant difference was found between groups (t=1,68).

For the second variable, that of age, the groups were again found to show no significant difference (z=1,25).

Of the test scores, there was no significant difference found between groups for the pre-test Dudec (z=0,25). The three subtests of the pre-test CTB were then looked at individually. No significant differences were found, namely the pattern reproduction test scores (z=0,93), the circles test results (z=0,31), and the form series test results (z=0,39).

Following the two training procedures, the post-test CTB was administered. No significant difference was found between the two groups for the post-test Dudec (z=0,45). There were also no significant differences on the three subtests, namely the pattern reproduction test (z=0,28), the circles test (z=0,37), and the form series test (z=0,06).

Statistical procedures were then applied within each group to test the null hypothesis that the means of each group were not the same on the post-test as on the pre-test. The 0,05 level of significance was used here, as it was throughout the study.

A significantly different result was found for the control group when the post-test results were compared with the pre-test results. For the Dudec this group improved significantly on the pre-test (z=4,07), as also in the pattern reproduction test (z=5,20), the circles test (z=4,41), and in the form series test (z=3,21).

The experimental group also showed a significant difference in results following their training programme. For the Dudec, the experimental subjects improved significantly (z=4,14), as well as on the pattern reproduction test (z=3,89), the circles test (z=4,04), and for the form series test (z=2,68).

It was desired to test for significant differences between variances, if possible. However, a look at the histograms showed that this was probably only possible for the Dudecs. All the other graphs showed either skewed or uniform distributions which did not lend themselves to the F test of significant differences between variances.

To make sure that the Dudec curves were within normal limits, the Chi Square value was determined for each of the four curves. All the curves were found to be only chance deviations from the norm. The control group's curve on pre-test was within normal limits (d.f.=4, X^2=3,652), as it was on post-test (d.f.=5, X^2=5,214). The curves of the experimental group were also well within normal limits on the pre-test (d.f.=4, X^2=1,112), and on the post-test (d.f.=4, X^2=3,278).

The F test was then applied to test for significant differences between the variances of the Dudec scores of the two groups at the 0,05 level of significance. It was found that on the pre-test the variance of the control group was significantly different from that of the experimental group (F=1,49). This seems to be due to the fact that the control group had more average scores and fewer extreme scores than the experimental group. However, on the post-test the variance of the two groups was not significantly different (F=1,01).

It was also found that the variance within the control group on the pre-test was not significantly different from that on the post-test Dudec (F=1,16). Neither was the variance on the pre-test for the experimental group significantly different from that on the post-test Dudec (F=1,04).

Finally, those subjects who did least well and those who performed the best according to Dudec scores were selected, and new group

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