c.1

THE RELATION OF PRIMARY REPRESENTATIONAL SYSTEMS AND VISUALIZATION TRAINING TO SPATIAL RELATIONS APTITUDE

by

© GLORIA MARY FORWOOD

B.Ed., The University of British Columbia, 1969
M.Ed., The University of British Columbia, 1977

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in

THE FACULTY OF GRADUATE STUDIES

(Department of Counselling Psychology)

We accept this thesis as conforming

to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

February, 1981

© Gloria Mary Forwood, 1981

In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the Head of my Department or by his representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Department of Counselling Psychology
The University of British Columbia
2075 Wesbrook Place
Vancouver, Canada
V6T 1W5

March, 1981

Abstract

It has long been realized that people differ in their ability to use their various senses in learning, and many research studies have attempted to train people to use their weaker modalities more effectively. It is suggested in a recent theory, Neurolinguistic Programming, that the way people receive and understand information is influenced not only by their external environment but also by their internal response to it. Thus they use sensory input channels, which bring information to their attention, and internal representational systems, which respond to the information and give it meaning.

One aptitude which may be affected by a person's primary representational system is visualization, or the ability to mentally manipulate objects. This aptitude is measured by spatial relations tests. It is possible that a person may see an image by means of his or her visual input system, but not have a strong enough visual representational system to hold that image and manipulate it mentally. The purpose of this study was, first, to investigate the relationship between the strength of the visual representational system and performance on a spatial relations test, and, second, to determine whether visualization training would improve performance on the spatial relations test.

The subjects in the study were 67 male and 71 female grade 10 students in a large, urban, multi-ethnic high

school. All wrote one form of the Space Relations subtest of the _Differential Aptitude Tests_ as well as two questionnaires designed to identify primary representational systems. Of those students who could be most clearly classified as visuals, 20 were randomly divided into two groups and the groups randomly assigned to the experimental or the control condition. The same procedure was followed to divide the non-visuals. One week later, the experimental group underwent visualization training while the control group took part in an unrelated activity. After another week, all the students wrote an alternate form of the space relations test.

An analysis of variance was run using the pretest and posttest scores and the visual or non-visual classification of the students. There was no significant difference between the arithmetic means of the visual and non-visual groups on either the pretest or the posttest and no significant difference between the posttest arithmetic mean of the group who received visualization training and that of the control group. No significant interactions were found between classification as visual or non-visual and membership in the control or experimental group.

Contrary to expectations, the primary representational system did not appear to be related to performance on the spatial relations test, and the visualization training did not appear to have improved the students' performance on the test. The unexpected results may have occurred because of inaccurate classification of the students' representational systems, inadequate visualization training, or the inappropriate use of group rather than individual methods to classify and train the students. The results may also have been influenced by other factors such as the age of the subjects, their inexperience with tests, their intelligence, or the relative strength of their representational systems. Further research will be needed to clarify the meaning of the results of this study.

<u>Thesis Supervisor</u>: Dr. R. Tolsma

TABLE OF CONTENTS

LIST OF TABLES

Acknowledgement

I would like to express my sincere appreciation to my thesis supervisor, Dr. R. Tolsma, and to my committee members, Dr. H. Ratzlaff and Dr. L. Greenberg, for their advice and help during the completion of this study.

I would also like to thank my husband, Garry, for his encouragement and support and for his invaluable help in the printing of this thesis.

CHAPTER I

Introduction

The Problem

The realization that people differ in their ability to use their various senses in learning is not a new one. Many research studies have measured not only people's preferences for visual, auditory, kinesthetic, or tactile modes of learning, but also their successes at learning material presented to them through these different senses. Investigators have also matched teaching methods to students' preferred modalities and attempted to teach students to use their weaker modalities more effectively. The results of such research have been somewhat inconsistent.

With their concept of Neurolinguistic Programming, Bandler and Grinder (1975, 1976) have outlined an even more comprehensive theory of the process by which people receive and represent information about their environment. They see two influences on this information processing: the external setting, brought to one's attention by a sensory input channel, and an internal response to it, giving it meaning in a representational system. The sensory input channels and the representational systems are vision, audition, kinesthesis, gustation, and olfaction, although the organization of behavior is accomplished mainly through the visual, auditory, and kinesthetic representational systems. Information taken in through one sensory input system may well be stored in another representational system. This occurs, for example, when a person sees a facial expression (visual input) but experiences a feeling (kinesthetic representation) rather than a visual image, and makes his or her decision based on that feeling.

As children grow, they learn to value the information from a particular representational system as an effective tool for dealing with their environments. Gradually, they may come to rely on one type of sensory information in most situations, even when another would be more appropriate. In addition, by using one sensory system more than the others, they will develop it more completely and have more distinctions available in that system with which to organize their experiences. Thus that system becomes the "primary representational system" -- the one which the person values and uses most.

Another body of research has dealt with spatial abilities, which involve the extent to which a person can perceive and compare patterns (perception), remain unconfused by the varying perspectives from which a spatial pattern may be presented (perspective-taking), and manipulate objects in the imagination (visualization). Attempts have been made to teach spatial abilities: experiments designed to help subjects improve their perception and perspective-taking have been fairly successful, but those concerned with visualization training have had more failure than success.

The effectiveness of instruction in spatial visualization is still controversial. Possible reasons for the inconsistent results are suggested in the literature, which will be reviewed fully in the next chapter. The degree of specificity of the training may be important, and some studies involve only training in related areas, such as geometry, which draw on spatial abilities but do not afford direct practice in visualization. Another possibility is suggested by research which indicates that visualization is more complex and requires a higher degree of visual imagery than perspective-taking or perception. If this is true, instruction which does not concentrate directly on this facet of spatial ability may not be adequate. Furthermore, if Bandler and Grinder are correct in their division of sensory input channels from representational systems, visual perception could conceivably occur through the visual input channel, yet not be retained in a visual representational system long enough or clearly enough for the mental manipulation of images to occur.

The purpose of this study is, first, to classify grade 10 students as having visual, auditory, or kinesthetic primary representational systems as indicated by their preferred input system, and then to compare each individual's indicated representational system to his or her approach to and success on a spatial relations test. Secondly, the study will attempt to directly teach visualization skills to the students by training which requires them to mentally see and manipulate objects and which incorporates Bandler and Grinder's approach of linking a favoured representational system with a weaker one.

The specific objectives of the study are as follows:

1. to identify people with visual, auditory, and kinesthetic primary representational systems, using a measure of preferred input systems,

2. to group those who clearly favour one representational system together and to randomly assign the members of each group to an experimental or a control condition,

3. to compare the approach subjects take in solving the problems on the DAT Space Relations Test with their identified primary representational systems,

4. to compare the scores obtained on the DAT Space Relations Test by visuals and non-visuals (auditories or kinesthetics),

5. to train all experimental subjects in visualization skills by having them create mental images and connect imagined sounds or feelings with visual images,

6. to engage the control group in a career exploration activity which is unrelated to visualization but which takes the same amount of time as the visualization training,

7. to compare each subject's score on a posttest, using an alternate form of the DAT Space Relations Test, with his or her score on the pretest,

8. to determine the relationships, if any, between membership in the visual or non-visual group, participation in the experimental or control condition, and improvement in scores from the pretest to the posttest.

Limitations and Assumptions

Certain limitations have been imposed on this study. First, the results are specific to grade ten students in a large urban school who have multi-ethnic backgrounds. According to a 1980 survey of the school population, approximately 38% come from English-speaking homes, 28% from Chinese-speaking homes, and 15% from Italian-speaking homes. The remaining students are from a wide variety of other language backgrounds. The participants in the study had also chosen to take part in a career planning mini-course. In addition, one instructor trained all of the experimental groups while another teacher worked with all the control groups. Although both these teachers regularly work together team-teaching the classes who took part in the experiment, the possibility of an experimenter effect does exist.

Furthermore, certain assumptions have been made. In planning the study, it was assumed that the students could be validly classified as having visual, auditory, or kinesthetic primary representational systems on the basis of their preferred sensory input system, and that enough of the students would show a clear tendency towards each of the preferred input systems to make the research possible. Bandler and Grinder imply that, although information may be taken in through one input system and stored in a different representational system, the preferred input system is the same as the primary representational system. This same assumption has been made in this study. An attempt was made to show the relationship between the measure of preferred input system and the primary representational system by comparing the resulting classification of each student to the method he or she used to solve the spatial relations problems, to the degree of visual imagery he or she reported having, and to his or her use of sense-related predicates and reports of preferred activities.

It was also assumed that, with respect to division into the different representational groups and to reaction to visualization training, there would be no difference between the students from different ethnic backgrounds and between males and females. Research concerning the spatial abilities of members of different cultures is summarized by Kagan and Kogan (1970). This research has generally shown that the cultural values of a society affect its members' perceptual and proprioceptive skills, but this would be reflected in their primary representational systems as well as in their performance on a spatial abilities test. Several studies have found that boys have outperformed girls on spatial visualization measures (Salkind, 1976; Conner, Schackman, and Serbin, 1978; Miller and Miller, 1977), and that this disparity has been reduced by training (Conner, Schackman, and Serbin; Miller and Miller; Eliot and Fralley, 1976). The norms in the DAT Manual also indicate that boys obtain slightly higher scores on the Space Relations subtest. However, other investigators have found no significant differences between the sexes in spatial abilities (Ciganko, 1973; Bruner, 1978; Cohen, 1976). Miller and Miller (1977) point out that many writers believe any differences in spatial ability by sex to be due to cultural expectations and differences in child rearing. While these differences have been found in many cultures (Eliot and Fralley, 1976; Mitchelmore, 1976), they do not seem to exist among Eskimos, Canadian Indians, or Australian Aborigines, cultures where perceptual skill is valued in both sexes (Mitchelmore, 1976). Thus any culturally-produced differences by sex should also be reflected in the primary representational system which has been adopted by each individual.

Importance of the Study

If Bandler and Grinder are correct in their assertion that many individuals have failed to develop one or more of their representational systems, then those individuals have deleted a part of their experience. The authors have discovered clinically that such a deletion makes interpersonal communication more difficult for a person: if it is shown to affect spatial relations ability, then it can also cut him off from training and career opportunities which require an ability to visualize. Drafting, Descriptive Geometry, Mechanics, Artistic Design, Engineering, Architecture, Sewing, and other fields have all been mentioned in connection with visualization ability. If the hypotheses of this study are confirmed, it will indicate, however tentatively, another effect of the underdevelopment of one or more representational systems. This must, however, be a tentative conclusion, since the theory of Neurolinguistic Programming has not been fully operationalized in this research. Bandler and Grinder have used the classification of representational systems in clinical rather than experimental work, and they have not developed a method of objectively measuring the systems.

This study might also suggest new directions for educational practice. Perhaps the use of all representational systems should be taught in schools. If such training were effective, students and society would reap the benefits in terms of improved communication skills and broader vocational and avocational possibilities. The results of the study might also suggest the possibility of identifying the primary representational systems of students who have difficulties in school in order to better understand their difficulties and help them to develop new systems. Bandler and Grinder identify their clients' primary representational systems and teach them new ones in individual clinical sessions; by attempting to do this with a group, this study examines the feasibility of introducing such training as a form of developmental education.

In addition, this experiment might help to clarify some of the contradictions found in the research on the teaching of visualization abilities. Because the training is aimed directly at the representational systems rather than at perceptual or perspective taking skills, which need involve only the sensory input channels, its success would suggest that this is an effective way of training for the manipulation of visual images.

Finally, if spatial relations ability is shown to be related to primary representational systems, then this would support other writers who have pointed out the limitations of our common definitions of aptitude. It has been defined as "a condition or set of characteristics regarded as symptomatic of an individual's ability to acquire with training some (usually specified) knowledge, skill, or set of responses, such as the ability to speak a language, to produce music...." (Psychological Corporation, 1948). Carpenter, Finley, et al (1965) go one step further by dividing aptitude into native capacity and developed capacity. After an experiment in which subjects were tested for spatial relations aptitude, instructed in spatial relations by various methods, and retested, they found no clear results and concluded that the reasons for success on Spatial Relations measures had not yet been successfully assessed. Because no formal effort is made to develop

Spatial Relations ability in most cases, the developed capacity in a group could vary widely, and those with high native capacity but low development should gain more than those with medium or high development but only low or medium native capacity. Snow (1976, 1977) also suggests that differences in aptitude should be understood as individual differences in psychological processes and that aptitude measures should not be seen as simply predictors. Aptitudes, he claims, are not permanent, and can be expected to develop or change with experience. Many studies have shown aptitude and treatment interactions, implying that neither aptitude constructs nor learning processes can be fully understood without reference to each other.

The hypotheses of this study imply that aptitude involves not only the ability to acquire a skill with training, but the way in which an individual has learned to represent the world. Thus the "aptitude" itself has been learned and can be further changed by training. In the terms of Carpenter, Finley, et al, the aptitude at any time is the current state of development of the native capacity. This definition of aptitude, as opposed to a static one, implies a profound difference in our view of a person's potential as measured by an aptitude test.

The hypotheses which this experiment has been designed to test may be stated as follows, using the null form:

1. The arithmetic mean on the pretest (DAT Space Relations subtest, Form S) of students whose primary

representational system appeared to be visual would not be significantly different from that of students whose primary representational system appeared to be non-visual (auditory or kinesthetic).

Statistical Hypothesis: $H_0: \mu_1 = \mu_2$

$H_1: \mu_1 \neq \mu_2$

2. The arithmetic mean on the posttest (DAT Space Relations subtest, Form T) of students whose primary representational system appeared to be visual would not be significantly different from that of students whose primary representational system appeared to be non-visual.

Statistical Hypothesis: $H_0: \mu_1 = \mu_2$

$H_1: \mu_1 \neq \mu_2$

3. The arithmetic mean on the posttest of students who received visualization training would not be significantly different from that of students who did not receive visualization training.

Statistical Hypothesis: $H_0: \mu_1 = \mu_2$

$H_1: \mu_1 \neq \mu_2$

4. There would be no significant interaction between the identified primary representational system and participation in the experimental or the control group.

Statistical Hypothesis: $H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4$

CHAPTER 2

Literature Review

Neurolinguistic Programming

In *The Structure of Magic I* (1975) and *The Structure of Magic II* (1976), Bandler and Grinder explain how people take in information by means of their sensory input systems and then organize that information and give it a personal meaning by means of the primary representational systems which they have learned to value the most. However, the authors go beyond an explanation of these processes to an effort to help people become conscious of all the parts of their input and representational systems so that, with a greater choice of responses, they can deal more appropriately with their experiences and communicate better with people who have different primary representational systems. They train their clients to use new representational systems by linking these to their existing primary representational systems. For example, a woman who is highly visual is asked, "how do you feel as you see your husband not noticing you?" If she cannot respond, she is asked to make a mental image of her husband and describe what she sees. Then she is to try, as she looks at the image, to become aware of any body sensations she is experiencing. Similarly, a woman who is undergoing emotional pain is asked to shift all her feeling into a visual representation and to describe it as clearly as possible. Bandler and Grinder describe this process in

Patterns of the Hypnotic Techniques of Milton H. Erickson, M.D. (1975, p.190):

> By using the client's most highly valued representational system as a lead system, the client can be helped to gain access to new states of awareness. For example: in one of our training sessions, a middle-aged psychologist complained that he was unable to make visual imagery, in spite of the fact that he had his clients use this technique. We had this man place his body in the position of playing his piano (his favorite hobby). He was then instructed to move his fingers in the pattern of a familiar tune. With his eyes closed, he was instructed to hear the tune internally as well as to move his fingers. He was then asked to look down at the keyboard. He exclaimed, "I can see the keys and my fingers on the keyboard!" He was then instructed to look up at the rest of the living room, and then at the people in the room. This technique of using highly valued representational systems to recover and improve impoverished ones is a common technique in our work. The main principal is simply to find a situation in which the impoverished system overlaps the developed system....

The authors suggest that people's primary representational systems can be identified by studying the sense-related words, or "predicates", they use most often and their occupations, interests, and talents. In addition, in _Patterns of the Hypnotic Techniques of Milton H. Erickson, M.D._ (1975, p.76), they mention a difference they have noticed between clients with visual and those with non-visual primary representational systems:

> Many times, in the course of teaching a client who has a most highly valued representational system other than visual, we have noticed the client making a distinction between "imaging a picture" and "seeing a picture". In the first case, the client, typically, reports vague, relatively unfocused, schematized and unstable visual images, while in the second case, the images have the focused, stable, full, rich, vivid properties of direct visual input. In every case to date, the experience of "imaging a picture" has associated with it a verbal, internal dialogue, while the vivid visualization has no internal verbal dialogue associated with it.

> Apparently, the first case is one in which the client is constructing a picture using his language system as the lead system, while the second is a direct accessing of pictures residing in the non-dominant hemisphere. Thus, one way which we have developed to assist the client in coming to have the ability to visualize vividly is to teach him to shut down his internal verbal dialogue.

Learning Modalities

Bandler and Grinder's work was preceded by many studies of learning modalities. Morency (1967) reported on a longitudinal study which, like the research she reviewed, suggested that children develop in their perceptual abilities between grades one and three, but not equally in each modality. Marcus (1977) gave a questionnaire to students about various factors which were important to their learning and found definite preferences for auditory, visual, kinesthetic, or tactile learning, as well as for differing degrees of structure, quiet, and so on. Teachers given the same questionnaire accurately perceived some of these factors, but not others, among them visual, tactile, or kinesthetic preferences. Similarly, Austin and Donovan (1978) reported a study by Dunn and Price where some of the students responding to a learning style inventory indicated a preference for learning by tactile or kinesthetic means, supplemented, but not replaced, by visual input.

In 1945, Viktor Lowenfeld developed a series of tests to place people on a continuum between the "visual" and the "haptic" modes of perception. Visuals were defined as objective observers who use their eyes as the main channel of information acquisition and transform tactile sensations to visual images. Haptics, on the other hand, acquire most of their information through tactile or kinesthetic means and feel no need to transform the sensations into visual images. They view the world subjectively and find it difficult to get an overview of the scene because they become lost in the details. Lowenfeld classified 47% of his subjects as visuals, 28% as haptics, and 25% as in the middle of the continuum. However, Dorethy (1975) questioned Lowenfeld's conclusions, since little information was given on test construction techniques or details of procedures, few controls for threats to validity were included, and only minimal statistical analysis was done to account for chance factors. The validity of Lowenfeld's results was also questioned by Schlenker, who replicated the study with grade nine, ten, and eleven students and found that some of the visual-haptic tests did not give accurate results. The students did appear to be distributed on a continuum, but the percentages in each category were different from Lowenfeld's.

Most of the research cited above suggested that some attempt be made to teach students in their preferred learning modality. In addition, Pfleger and Pulvino (1977) directly linked the theory of Neurolinguistic Programming, the research on learning modalities, and the ideas of J.E. Hill (1976), who stated that individuals establish one or a combination of input channels as being the most useful for learning, and that they develop ways of responding in keeping with these. Building on these ideas, the authors suggested examining student essays for words which would indicate the preferred learning modality and then teaching by the appropriate means.

Attempts have indeed been made to match teaching methods to learning modalities, but the results have been inconsistent. On the one hand, Donovan and Austin (1978) found that kindergarten pupils in congruent placement for their learning modality scored significantly higher on reading measures, and both they and Patridge (1976) cited other studies which have had similar results. Lilly and Kelleher (1973; cited in Newcomer and Goodman, 1975) found that retarded children performed significantly better when taught in their preferred mode, and Burcham et al (1977) found that retarded males aged nine to thirteen who were high in auditory discrimination learned an auditory paired associate learning task better, although there was no significant difference between auditory and visual learners on a visual task. Gaddies (1975) described a successful tactile approach to teaching a brain-damaged boy to write and spell and Segal (1976) the successful use of tactile and kinesthetic techniques in teaching learning disabled children. Taschow (1970) and Caukins (1971) discussed the improvement students achieved in spelling when taught by a visual- auditory-kinesthetic-tactile technique, which meets the needs of students with any preferred modality.

On the other hand, many investigators have found no significant advantage for students in congruent placement. Janssen (1973) and Serapiglia (1974) obtained this result working with young children with visual or auditory preferences; Austin and Donovan (1978) mentioned several other researchers who found that visual or auditory learners did no better when the teaching method was matched to their modality. One study cited in Austin and Donovan's article included kinesthetic and combined modality preferences as well, and still found matching to be no advantage. After an extensive review of the literature, Newcomer and Goodman (1975) concluded that auditory learners seem to do better than visual learners, regardless of the mode of presentation, and that auditory methods are better for all students. However, in their own study, the visual learners tended to do better, although students low in auditory abilities had the most difficulty. Robinson (1972) found only that students higher in both auditory and visual modalities obtained higher reading scores than those low in both modalities, whether they were taught by phonics (auditory approach) or whole words (visual approach). Students high in one modality and low in the other did no better in congruent placement.

Why is there this inconsistency in the research? Janssen, Waugh, Newcomer and Goodman, and Austin and Donovan all suspected that the difficulty might lie in the method of classifying students by preferred learning modality. The construct validity of the perceptual tests used was often questionable. Newcomer and Goodman also criticized the assumption of equal differences between scores when placing students on a visual-auditory continuum and some instructional techniques which emphasized one modality but, in reality, included others. This inconsistency does not invalidate the theory of preferred learning modalities, but it does indicate a need for further research to clarify the effects of matching teaching methods to modality preference.

Spatial Abilities

"Spatial Abilities" is a rather broad term which French (1951; cited in Eliot and Fralley, 1976) divided into three factors:

> Perceptual -- the ability to perceive patterns accurately and to compare them to each other;
>
> Orientation -- the ability to remain unconfused by the varying perspectives from which a spatial pattern may be presented;
>
> Visualization -- the ability to use visual imagery and manipulate objects in the imagination.

Zimmerman (1954) thought that each of these factors comes into play sequentially, as a task becomes more difficult, but Smith and Taylor (1967) thought that the difference lies in the type of organization required, not in the difficulty of the task. Other investigators have examined the possibility that the three factors are interrelated. Frederickson (1970), for example, found that subjects differed in their perception of two and three dimensional shapes according to their "perceptual style":

those who were greatly influenced by observer and stimulus orientation (field dependent) showed greater variation in their judgements than did those who were not so influenced (field independent), yet shape was judged with more consistency than rotational orientation by both groups. Preston (1977) concluded that a Piagetian perspectives task was related to visual imagery after an experiment with six, nine, eleven, and fifteen year old children, and Peterson (1975) hypothesized an overlap between perception and visual imagery after finding that the patterns of recall for matrices constructed in the imaginations of his adult subjects approximated those for matrices actually seen by the subjects, although recall was greater for the seen matrices. Peterson supposed that perception is more closely associated with the external stimulus and visual imagery with the internal representation of spatial characteristics, but that the interrelationship is there, nonetheless. Similarly, Bruner (1978) found performance on the _Embedded Figures Test_, which measures perception, to be related to visual-spatial ability.

Both Millar (1976) and Marmor and Zaback (1976) compared the spatial visualization abilities of the early blind, later blind, and sighted. Millar found that blind and sighted children did equally well on a haptic perception task but that, on a mental rotation task, the sighted did best, followed by the late blind, followed by the early blind. The degree of rotation of the objects significantly affected the scores of the blind but not those of the sighted. Marmor and Zaback also found that their blind subjects -- adults this time -- took longer and made more errors when comparing two objects at different rotations, presented tactually. The blind were, however, able to organize spatial representations without visual imagery, and an increase in the angle of discrepancy between the two objects did increase the difficulty of the task for the sighted subjects as well as for the blind in this experiment.

Two studies lend support to Zimmerman's idea that French's three factors represent a hierarchy of spatial abilities. Schroth (1967) tested the belief that manipulation of visual forms in spatial relationships is common to all art production. He discovered that college Fine Arts majors, presumably trained in visual perception, and a representative sample of non-Fine Arts majors did not obtain significantly different scores on the Space Relations subtest of the Differential Aptitude Tests. Furthermore, there was no significant correlation between the Art majors' scores on the DAT and on the Meier Art Judgement Test. Since previous research using the Minnesota Paper Form Board Test found a relationship between spatial relations ability and art judgement, the author tentatively concluded that the DAT may tap a more complex aspect of spatial ability than does the MPFB. In an experiment by Barrett (1953), twenty-three spatial tests were given to a group of undergraduate students and a factor analysis was run to identify groupings of variables. Two distinct groupings were found -- spatial manipulation and reasoning -- and a possible third -- shape recognition -- was partially defined. Subjects who rated mental imagery as playing an important part in their solution of the problems did significantly better on spatial manipulation tests but had no advantage on those measuring spatial reasoning. Imagery also appeared to have some importance in shape recognition, but this finding could only be tentative because of the poor definition of the factor. Barrett concluded that spatial manipulation requires a high degree of control of clear, well-defined images, but that shape recognition requires only imagery of a lower order, sufficient to directly compare shapes.

Although the above research was mainly concerned with visual spatial abilities, other investigators have examined the commonality of spatial operations across sensory modalities. Lindgren (1978) found a significant correlation between results on tactile-spatial and visual-spatial tests by children aged six to thirteen. Lolla (1973) summarized a review of research and stated that transfer of training in form discrimination had been clearly shown to occur between vision and touch: learning shapes in one modality made it easier to relearn forms in another. He also noted that visual imagery has been shown to play an important role in tactual form perception and in the giving of verbal information about a design. Williams and Aiken (1977) demonstrated that grade two, grade six, and university undergraduate students processed both auditory and visual representations of the same pattern in the same manner.

Imaging itself need not be exclusively visual. Leibovitz, Cooper, and Hart (1972) determined that different people use different modalities most often for imaging, and that 77% of those who showed dominance in one modality were deficient in one or more of the others. These findings were in contradiction to previous research, which indicated that imagery ability is equal across modalities, and they suggest a connection to Bandler and Grinder's primary representational systems. Visual imagery was indeed found to be the most common form, favoured by 33% of the subjects, followed by auditory imagery (19%), kinesthetic imagery (18%), tactile imagery (16%), and olfactory-gustatory imagery (14%). Looking at imagery from another point of view, Hartsough and Laffal (1970) continued the work of several investigators who had found that people could be classified as visual imagists —who think in pictures — or as verbal imagists — who talk to themselves as they think. They studied the writings of many scientists and found, as had Roe (1951 to 1961), that Social Scientists and Theoretical Physicists tended to be verbal imagists while Biologists and Experimental Physicists were usually visual imagists.

In a study of spatial abilities as measured by the Space Relations subtest of the Differential Aptitude Tests, mental visualization would appear to be the most relevant spatial factor. The DAT Manual describes that subtest as measuring the ability to mentally manipulate objects in three-dimensional space, and comments that the figures have been designed to be clear and unambiguous so that the perception of differences is not difficult. In addition, Glover (1974) discovered a positive relationship between scores on the DAT Space Relations test and the time and intensity of sustained Alpha rhythms which were measured when subjects were given a series of tasks designed to stimulate visualization, Barrett (1953) found that subjects who felt a greater need for the easy manipulation of clear, strong visual images on spatial visualization tests did significantly better, and Ciganko (1973) determined that performance on spatial visualization tests was more closely related to the dependent variables associated with drawing a visualized stimulus than an observed stimulus.

Many researchers have stated their belief that spatial abilities can be taught. Lolla (1973) listed several, including McKim (1972), Arnheim (1969), and Smith (1967). Dorethy (1975) disagreed with Lowenfeld's Visual-Haptic theory not only because of the experimental methods but because he believed that individuals could learn new perceptual abilities. Indeed, Neurolinguistic Programming, with its emphasis on helping people to use input channels and representational systems which are unavailable to them, implies that this sort of ability can be learned.

Attempts to teach spatial abilities have met with mixed success. Those concentrating on perception have produced the most improvement in subjects' abilities. Rawls (1967) trained a group of deaf children in visual perception and found that their scores on visual discrimination and perception tests and also on learning aptitude tests increased; Egeland (1967) and Elkind and Deblinger (1968) had success with learning disabled children, who improved in reading skills after perceptual training. Weiderholt and Hammill (1971), on the other hand, found that non-perceptually handicapped students who completed over 200 worksheets of the Frostig-Horne Visual Perception Program improved their performance on Frostig's Developmental Test of Visual Perception, but that perceptually handicapped students did not. Similarly, Resnick (1968) found that first graders trained in identifying objects in increasingly detailed drawings showed an acceleration in the development of this ability, but that students from disadvantaged backgrounds showed less improvement. Cowles (1969) noted that grade one students who had received visual perception instruction showed a significantly greater improvement on the Metropolitan Readiness Tests than a control group, who had engaged in listening activities, and Connor, Serbin, and Schackman (1977) found that girls trained in perceiving embedded figures improved in this ability, although the boys in the study did not.

Two other studies described training in perspective taking ability. Cox (1978) had a small group of five year olds describe relationships between objects, the observer, and themselves. Verbal feedback was given. Those so trained scored significantly higher than their controls on a posttest and on tests seven weeks and seven months later. Priddle (1977) taught preschool children left-right relations by either verbal instructions and visual cue cards, or by body movements. The kinesthetically-taught group were better able to identify these positions, but both groups improved somewhat in more general spatial perspective skills.

Experiments in visualization training have had more inconsistent results. Brinkman (1966; cited in Eliot and Fralley, 1976) described a study in which grade 8 students, having taken geometry lessons including pattern folding and manipulation, showed a significant improvement on the DAT Space Relations posttest over the pretest. Likewise, Conner, Schackman, and Serbin (1978) trained grade one children with a set of embedded figures, then tested them on the Sternglanz-Lifschitz Folding Blocks Test, an adaptation of the DAT Space Relations subtest. While the scores on an embedded figures pretest were predictive of posttest scores on the Folding Blocks Test for the control group, this was not true for the experimental group. Darrow (1973) also had success when he trained subjects by having them form closures on ambiguous stimuli and visually articulate changes in objects and object parts. They improved their scores on the DAT Space Relations posttest.

However, Wolfe (1970) doubted the generalizability of training using tasks which parallel those on spatial relations tests, since the subjects in his study showed little gain afterwards on other tests presumably measuring the same abilities. Lolla (1973) did not succeed in improving spatial visualization by training, either. He used wooden blocks as tactile stimuli and had his ninth grade subjects practise matching them with pictorial line drawings. Students classified as high in visual imagery, on the basis of pretest scores on the Revised Minnesota Paper Form Board Test, scored significantly higher on the DAT than did the low visual imagery group, regardless of whether they were in the experimental or the control condition, and the high visual imagery control group's scores were significantly higher than those of the high visual imagery experimental group. It would appear that the training actually interfered with these students' ability.

In only two studies did there seem to be an attempt to train visualization ability by the direct use of visualization rather than perceptual exercises. Ciganko (1973) compared a group of grade nine students trained by drawing from directly observed stimuli with a group of similar students who practised drawing from visualized stimuli. Both groups improved significantly in spatial visualization scores. The students trained by drawing observed stimuli tended to include more spatial information in their drawings of visualized stimuli, but performance on spatial visualization tests was found to be more related to the variables associated with drawing a visualized stimulus than an observed one. Some years before, Van Voorhis (1941; cited in Lolla, 1973) trained college students with visualizing exercises, such as estimating linear extent, angles, and areas or engaging in three dimensional tick-tack-toe, and found that his experimental group showed a significant improvement on the cards and figures section of the Thurstone Test for Primary Mental Abilities.

In addition to the research reporting the results of experiments in visualization training, another body of work examined the effects of incidental visualization instruction occuring in the course of presumably related studies. For example, Lolla (1973) cited four such reports: Blade and Watson (1955) noted a significant gain in spatial relations test scores for college men who had completed one year of Engineering courses; Myers (1951, 1953) reported a similar increase in spatial relations test scores after both a course in military topographics and graphics and a course in engineering drawing and descriptive geometry. On the other hand, Myers (1958) found that mechanical drawing taken in high school had very little effect on the spatial relations scores of military cadets, and Sedgewick (1961) discovered no significant differences on the DAT Space Relations posttest he gave to matched pairs of Engineering, Industrial Education, and Industrial Supervision students, whether or not they had taken descriptive geometry since the pretest.

It is therefore uncertain whether spatial visualization can be effectively taught. Several possible explanations for the inconsistent results have been mentioned in the literature. Lolla (1973), for example, thought that the degree of specificity of the training is important, and he also noted that the research supported the idea of brief rather than prolonged training. Nevertheless, his own study did not prove successful in spite of his use of brief, specific instructional sessions. The writings of Zimmerman, Scroth, and Barratt suggest that visualization is more complex than perception or perspective taking, and that instruction which does not concentrate directly on this facet of spatial ability may not be adequate. Finally, Bandler and Grinder's theory implies that perception could occur through a visual input channel yet not be represented internally in a clear enough manner for the mental manipulation of images to occur. The experiment outlined in the next chapter was designed to explore the possibility that direct training to develop a person's visual representational system could improve his or her performance on a spatial relations test.

CHAPTER 3

Method

Pilot Study

In an attempt to see whether or not it would be possible to classify students according to their primary representational systems and whether this classification would bear any relation to their method of solving a spatial relations problem, an intact class of grade nine students, with fourteen girls and fifteen boys, was asked to participate in a pilot study. They were told that they would be taking part in a study related to the ways that people deal with information, and that they would be asked to write a short essay that day in class and then to come for a five to ten minute private interview with their teacher the next week. The students wrote their essay on the topic "If you could learn any language immediately and with no effort, which ones would you choose to learn and what would you do with them?" During the interview, they were asked to solve one problem from the DAT Space Relations test and then tell the interviewer whether they had been able to see the drawing move in their minds, whether they had talked to themselves as they solved the problem, and whether they had felt a strong desire to pick up the drawing and fold it together. They were also asked to talk about some of the activities they enjoyed doing in their free time, and to describe an ideal setting in which they would like to be working in a few years.

Several conclusions were reached as a result of the pilot study. The essay topic was a poor choice, since the focus on language use brought about a preponderance of auditory predicates. In addition, many of the essays did not include enough detail to assess the type of predicates used most often. During the interviews, on the other hand, the interviewer could explain to confused students what was wanted or ask them to continue their descriptions with more detail. The concern was, of course, to avoid "leading" the students into giving answers they would not have given on their own. It was decided not to use an essay as a classifying technique during the experiment, but rather to compose a series of carefully worded multiple choice questions and incomplete sentences to ascertain the approach the students used in solving the spatial problems and the aspects of their environments which were most meaningful to them.

During the interviews, it became evident that individuals approached the task in different ways. Nine of the twenty-eight students showed a clear preference for one representational system. For example, one student who would very much have liked to pick up the drawing, and who moved her fingers while attempting to find the answer, stated that she wanted to work in a "comfortable" office that "feels good". Another, who was unable to visualize the movement of the drawn pattern at all, was not even able to say what his work environment would look like; he responded that he would be physically active and have breaks to take part in sports. Similarly, a girl replied that the place where she worked would look "quiet". Other students told the interviewer that they were able to see the pattern move, wanted to work in settings that were "open" and "bright", and had "posters", "colours that aren't blah", and "carpets that look nice". Although not all students who seemed to be visuals chose the correct answer, none of the non-visuals solved the problem correctly. Because of these results, it was decided that the classification of students by primary representational systems should be possible.

Experimental Study

Subjects

Subjects were 138 grade ten students, 67 male and 71 female, who had chosen to take a career planning mini-course as a part of their guidance program. All were students at Vancouver Technical School, a large urban high school with a multi-ethnic population. According to a 1980 survey, approximately 38% of the students were from English-speaking homes, 28% from Chinese-speaking homes, 15% from Italian-speaking homes, and the rest from a wide variety of other language backgrounds. The students who took part in the experiment were distributed among six classes. By means of a measure of preferred input system, students were classified as visuals, auditories, tactiles (kinesthetics), or combined/unclassified. From those who could be most certainly classified as visuals, 20 were randomly divided into two groups. Then each group was randomly assigned to the experimental or the control condition. Similarly, from those students who could be most certainly classified as non-visuals (auditories and kinesthetics), 20 were randomly selected and then randomly divided into two groups, and those two groups were randomly assigned to the experimental or the control condition.

Experimental Design

A 2x2 factorial design was used, which can be represented as follows:

$$
\begin{array}{lllll}
R & O_1 & X & Y_1 & O_5 \\
R & O_2 & Z & Y_1 & O_6 \\
R & O_3 & X & Y_2 & O_7 \\
R & O_4 & Z & Y_2 & O_8
\end{array}
$$

Where:

R = Random assignment to groups

O_1, O_2, O_3, O_4 = Pretest

X = Visualization training

Z = Activity not related to visualization

Y_1 = Visual group

Y_2 = Non-visual group

O_5, O_6, O_7, O_8 = Posttest

Treatment

Visualization Training: The training occurred during regular class time and was conducted by one of the two counsellors who regularly teach the guidance classes. It comprised one fifty minute session and a twenty minute review session one week later. Students were told that the purpose of the training was to help them see and, move objects in their imagination. They were asked to close their eyes and try to see themselves walking home from school, noting familiar landmarks as they went. They were asked to feel their bodies moving, to feel themselves taking steps and touching things, and then to concentrate on how things looked as they were feeling these sensations. They were also asked to hear the sounds along the way and to concentrate on how things looked as they heard these sounds. The same sensory matching was used as they were told to imagine themselves arriving home. They were asked to stand in front of their house and look at it, then to walk around and see the house from different angles, describing it verbally to themselves and then concentrating on the visual image without using words or feeling themselves standing there. In a similar way, they were told to pick up various objects and examine them from different angles and to place other objects on a table in a specific relation to each other and look at them from all sides. One week later, the group met again for twenty minutes. They did a brief, similar visualization exercise and then were given a few minutes to practise visualizing on their own. At the end of this time, they wrote the posttest. The complete script of the training session can be found in Appendix A.

Control Condition: The control group also met for one fifty minute session during their regular class time. They took part in discussion and practice of job application forms and interview techniques, an activity not related to visualization. The other counsellor who regularly taught the guidance classes conducted this session. The control group also met again for twenty minutes one week later before joining the experimental group to write the posttest.

Procedure

All students in the careers mini-course took the DAT Space Relations subtest as a part of their self-exploratory activities. Just before they took it, they were told the following:

> The next activity in this mini-course will allow you to explore one of your abilities that you may not know much about — spatial relations. This is important in a lot of job areas like drafting, engineering, artistic design, sewing, and so on. You have some idea about your ability to use language and your ability with numbers from your school courses, but you may not have had much to do with spatial relations.
>
> We are also going to ask you to take part in an experiment while you are doing this. This is for a Master's Degree thesis at U.B.C. and the results will be brought together and written up. We can't tell you very much about the experiment until it's over, but it is designed to see how doing different activities will affect your ability to solve the problems on this test.
>
> This is not a "test" in the sense of a grading device, but just a way to learn about yourselves. You can't fail it. Also, we are not looking for any deep psychological things about you — just your spatial relations ability.
>
> The test itself takes 25 minutes. Then we'll ask you to fill in two other questionnaires related to the experiment.

The two counsellors took turns giving this introduction to the six classes. When the students had finished the DAT Space Relations test, they completed the Learning Style Self Inventory, which asks about the ways they prefer to take in information, and a short questionnaire requesting information about the way they solved the problems on the test as well as their ideas on various topics (to provide predicates and information on their interests for classification of their primary representational systems.)

Those who showed a clear preference for one input system, based on their scores on the Learning Style Self Inventory, were then grouped as visuals or non-visuals. Twenty members of each of these groups were randomly chosen and assigned to the experimental or control condition. The week after they took the test, the experimental and control groups met at the same time, but in different rooms, for their fifty minute sessions. One week after that, the experimental and control groups again met separately for twenty minutes and then all wrote the alternate form of the DAT Space Relations test.

Instrumentation

Learning Style Self Inventory: Working from the assumption that no two students seek information in the same way, Dr. Joseph E. Hill developed the Learning Style Self Inventory to determine an individual's educational cognitive style, or the manner in which he or she takes note of the total surroundings and becomes informed. The instrument identifies students' cognitive strenghts and weaknesses, and this information can be used to build personalized programs of instruction for them, as has been done at Oakland Community College (Hill, 1976). Several studies, mentioned by Berry, Sutton, and McBeth (1975), have shown cognitive style matching to be an advantage.

The Motivation to Learn Centre, Milwaukee, Wisconsin has done extensive research on cognitive style and has used the Learning Style Self Inventory with grade ten students. It is reported from the Centre that three separate studies have provided reliability and validity data for the instrument. Kuder-Richardson reliability coefficients ranged from .70 to .96. Predictive validity coefficients were determined for each trait, and the ranges for the three studies were $r_{p.b.}$ = .61 to .95, .68 to .93, and .73 to .92.

For this study, the sections of the inventory associated with sensory stimuli were used. Pfleger and Pulvino (1977) also used Hill's inventory to identify primary representational systems. The sensory elements of cognitive style were defined by Hill (1976) as being:

> Qualitative Auditory -- ability to perceive meaning through the sense of hearing...
>
> Qualitative Tactile -- ability to perceive meaning by the sense of touch, temperature, and pain;
>
> Qualitative Visual -- ability to perceive meaning through sight.

Two other categories -- Qualitative Olfactory and Qualitative Gustatory -- are recognized but not included in the inventory.

Students answer questions such as "The tone of a speaker's voice adds meaning to their words" and "I like to use my hands when learning about something" by "Usually" (5 points), "Sometimes" (3 points), or "Rarely" (1 point). A score of 30 or more out of a possible 40 points indicates a major orientation in that element; 18 to 27, a minor orientation, and 17 or less, a negligible orientation. The section of the inventory which was used in this study is reproduced in Appendix B.

Questionnaire: This questionnaire, which is reproduced in Appendix C, had four parts: a multiple choice question asking students how they solved the spatial relations problems, two multiple choice questions asking about the work setting and the holiday setting they would most enjoy, a question about the quality of visual image they could make of their living rooms, and a series of sentence stems which they were to complete in any way they wished.

The sentence stems used were chosen from a longer series which was given to a pilot group of 72 grade eleven and twelve students in an elective psychology course. Two raters scored that pilot questionnaire, and the results were analyzed. Sentence stems which frequently failed to stimulate a classifiable response, which consistently elicited predicates from one representational system, or which often stimulated responses on which the raters did not agree were eliminated. This section of the questionnaire was scored on the basis of the predicates used (visually, auditorially, or kinesthetically-oriented words) and the activities enjoyed by the student. Two raters independently determined the number of responses indicating visual, auditory, and kinesthetic preferences or no clear preference. Their scores were then averaged to provide the overall rating for the questionnaire.

The same questionnaire was given two weeks later to a random sample of thirty of the students and the preferences judged to be shown at each time were compared. Only fifty-seven percent had the same overall rating both times, but this was largely because of a wide variation on the incomplete sentences sections of the test, where the agreement in ratings was only fifty-three percent. These sections of the test were not used in any of the analyses. The other sections of the questionnaire had somewhat higher agreements between the two ratings. Seventy percent of the respondents were rated the same both times on their approach to the DAT test, sixty-three percent were rated the same on their choice of holiday and work settings, and seventy-six percent on their clarity of mental imagery.

In addition, an attempt was made to establish some validity for the instrument by comparing the primary representational system judged to be present with the approach the student used in solving the spatial relations problems. Because of the lack of consistency in the answers on the incomplete sentences sections of the questionnaire, these sections and the total rating were not included. When each student's approach to the DAT was compared to his clarity of mental imagery rating, fifty percent of the answers were consistent. When it was compared to his choice of holiday and work setting, fifteen percent of the responses matched exactly and fifty percent matched on at least one choice of setting.

It had been hoped that students could be classified by primary representational systems on the basis of this questionnaire, but the results indicated that it could not be considered a valid instrument for this purpose. For this reason, the Learning Style Self Inventory was used to define the visual and non-visual groups, and the information from this questionnaire was examined only in post-hoc analyses.

Pretest-Posttest: The Space Relations subtest of the Differential Aptitude Tests requires an individual to mentally manipulate objects in three dimensional space. Each question has a large, clear drawing of a pattern and a series of four drawings of three dimensional figures. The person is asked to choose the figure which could be made from that pattern if it were cut out and folded together. The Fifth Edition Manual (Bennett, Seashore, and Wesman, 1974) lists reliability coefficients for the Space Relations subtest of .94 (Grade 10 boys) and .89 (Grade 10 girls) for Form S, and of .92 (Grade 10 boys) and .93 (Grade 10 girls) for Form T. These are split-half reliability coefficients corrected for full length by the Spearman-Brown formula.

The manual reports extensive validity data for Forms S and T and also for the previous forms, L and M. Unfortunately, the predictive validity of the <u>Differential Aptitude Tests</u> is based on combinations of subtests, and the predictive validity of the Space Relations subtest alone is not provided.

The coefficients of correlation between the Spatial Relations subtest on Form S and that on Form T are given for Grade 9 students. These were .79 for boys and .71 for girls, when Form S was given before Form T.

<u>Hypotheses</u>

The hypotheses, stated in null form, were:

1. The arithmetic mean on the pretest (<u>DAT</u> Space Relations subtest, Form S) of students whose primary representational system appeared to be visual would not be significantly different from that of students whose primary representational system appeared to be non-visual (auditory or kinesthetic).

Statistical Hypothesis: $H_0: \mu_1 = \mu_2$

$H_1: \mu_1 \neq \mu_2$

2. The arithmetic mean on the posttest (<u>DAT</u> Space Relations subtest, Form T) of students whose primary representational system appeared to be visual would not be significantly different from that of students whose primary representational system appeared to be non-visual.

Statistical Hypothesis: $H_0: \mu_1 = \mu_2$

$H_1: \mu_1 \neq \mu_2$

3. The arithmetic mean on the posttest of students who received visualization training would not be significantly different from that of students who did not receive visualization training.

Statistical Hypothesis: $H_0: \mu_1 = \mu_2$

$H_1: \mu_1 \neq \mu_2$

4. There would be no significant interaction between the identified primary representational system and participation in the experimental or the control group.

Statistical Hypothesis: $H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4$

CHAPTER 4

Results

An analysis of variance was run using the pretest and posttest scores and the visual or non-visual classification of the students. The results were as follows:

Hypothesis 1

It was stated in the first null hypothesis that the arithmetic mean on the pretest (DAT Space Relations subtest, Form S) of students whose primary representational system appeared to be visual would not be significantly different from that of students whose primary representational system appeared to be non-visual (auditory or kinesthetic). The results of the first analysis of variance are shown in Table I below.

Table I - DAT Pretest Scores by Visual/Nonvisual Classification

Source of Variation	Sum of Squares	DF	Mean Square	F
Main Effects (Vis/Nonvis)	57.600	1	57.600	0.49
Residual	4486.785	38	118.073	
Total	4544.387	39	116.523	

These results indicate that the null hypothesis should not be rejected ($F = 0.49$, $p > .05$). The students classified as visuals and those classified as non-visuals did equally well on Form S of the DAT Space Relations subtest. Contrary to the expectations, having a representational system which had been identified as visual seemed to be of no advantage to the students in doing the test.

Hypothesis 2

In this null hypothesis it was stated that the arithmetic mean on the posttest (DAT Space Relations subtest, Form T) of students whose primary representational system appeared to be visual would not be significantly different from that of students whose primary representational system appeared to be non-visual. The results of the Analysis of Variance are summarized in Table II below.

Table II - DAT Posttest Scores by Visual/Nonvisual Classification by Training

Source of Variation	Sum of Squares	DF	Mean Square	F
Main Effects Visual/Nonvisual Training	139.250 46.225 93.025	2 1 1	69.625 46.225 93.025	0.52 0.35 0.70
2-Way Interactions (Vis/Nonvis by Train)	164.025	1	164.025	1.23
Residual	4819.473	36	133.874	
Total	5122.750	39	131.353	

As a group, the visual students did no better or worse on Form T of the DAT Space Relations subtest than did the non-visuals. This would indicate that the second null hypothesis should not be rejected.

Hypothesis 3

The third hypothesis, stated in the null form, was that the arithmetic mean on the posttest of students who received visualization training would not be significantly different from that of students who did not receive visualization training. The results are shown in Table II above. Once again, the null hypothesis was not rejected ($F = 0.695$, $p > .05$). The visualization training did not seem to have improved the students' performance on the Space Relations test. This was true for both the visual and the non-visual groups.

Hypothesis 4

It was stated in the fourth null hypothesis that there would be no significant interaction between the identified primary representational system and participation in the experimental or the control group. This hypothesis was tested in the analysis of variance whose results are summarized in Table II above. No significant two-way interactions were found ($F = 1.225$, $p > .05$), therefore the null hypothesis was not rejected. The arithmetic mean of the non-visual group who received training was not significantly different from that of the visual group who received training, nor was the arithmetic mean of the non-visual group who did not receive training significantly different from that of the visual group who did not receive training. Similarly, the arithmetic mean of the non-visual group who received training was not significantly different from that of the non-visual group who did not receive training, and the arithmetic mean of the visual group who received training was not significantly different from that of the visual group who did not receive training.

Contrary to expectations, all of the null hypotheses were accepted on the basis of the results. The students' primary representational systems, if they were correctly identified, did not appear to be related to their performance on the DAT Space Relations subtest, and the visualization training was not successful in improving students' scores on the test. Since the literature appeared to lend support to a positive relationship between visual primary representational systems, visualization ability, and performance on Space Relations tests, a number of post hoc analyses were performed to search for possible reasons for the negative results.

Post Hoc Analyses

The Learning Style Self Inventory, reproduced in Appendix B, was used to classify the students as having visual or non-visual primary representational systems. An assumption was made that the preferred input system, which is measured by this instrument, would be the same as the primary representational system. The LSSI scores for each category of input system were compared to the DAT Space Relations scores by means of a Pearson Product-Moment Correlation. There was no significant correlation between the Auditory or Tactile scores and the DAT scores ($r = .22$ and $.29$, respectively; $p > .05$). However, surprisingly, there was a significant negative correlation between the Visual scores and the DAT scores ($r = -.43$, $p < .05$).

The classification of input systems was also compared to three of the sections on the questionnaire which attempted to identify primary representational systems (See Appendix C). When the classifications were compared to the approaches used in solving the Space Relations problems ("I could quite easily see the patterns move and form the correct shapes"; "I talked to myself"; "I had trouble imagining how the pattern would move and would have liked to pick it up"), 35% of the 40 cases matched. 48% were not inconsistent, including tactile people who talked to themselves about the patterns since they were unable to pick them up. In comparison with clarity of mental imagery ("The picture was clear and in focus"; "I talked to myself to help me get the picture right"; "The picture was unclear and I had trouble keeping it clearly in mind"), 38% of the 40 classifications matched. In addition, some students had two major strengths on the LLSI and used the most appropriate one, so that 55% of the cases were not inconsistent. When compared to the choice of holiday and work setting (concentrations of visual, auditory, or kinesthetic descriptors), 40% of the 40 classifications matched exactly while 52% matched on at least one choice of setting.

In a further attempt to relate Space Relations performance to visualization ability and primary representational systems, the DAT scores were compared to the questionnaire sections on clarity of mental imagery, approach to the Space Relations test, and choice of holiday and work setting. The mean scores on the DAT for students selecting the various choices are summarized below in Table III. The maximum score on the DAT is 60.

Table III - DAT Scores and Questionnaire Responses

Clarity of Mental Imagery	N	Score
-clear image	27	33.1
-talked to self	8	26.6
-clear image and talked to self	3	43.0
-unclear image and did not talk to self	2	26.0
Approach to the test	**N**	**Score**
-vis. (saw the pattern move)	10	32.8
-aud. (talked to self)	21	33.4
-kin. (wanted to pick it up)	9	28.7
Choice of holiday and work setting	**N**	**Score**
-2 vis. preferences	6	28.6
-2 aud. preferences	3	37.6
-2 kin. preferences	11	28.9
-1 vis., 1 aud. preference	9	36.8
-1 vis., 1 kin. preference	5	27.6
-1 aud., 1 kin. preference	6	35.8

N = Number of students who selected that possibility
Score = Mean score on the DAT
vis. = visual primary representational system
aud. = auditory primary representational system
kin. = kinesthetic primary representational system

Finally, accuracy scores (number correct/number attempted) on the Space Relations test were computed for the visual and the non-visual group, since there was a possiblity that visual students had solved the problems slowly but accurately while non-visual students had guessed at many of the questions and thus worked more quickly, finishing more questions. For the visual group, the accuracy was 70.0% on the pretest and 72.3% on the posttest. For the non-visual group, it was 79.6% on the pretest and 82.1% on the posttest.

For the most part, the post hoc analyses did not indicate any reasons for the unexpected results of the analyses of variance. The answers on the questionnaire did not relate closely to the scores on either the LSSI or the DAT. There did, however, appear to be a slight indication that having a visual preferred input system, as identified by the LLSI, was a disadvantage when solving spatial relations problems. Scores on the visual part of the inventory were negatively correlated with scores on the DAT Space Relations subtest, and the students classified as visuals even appeared to have been slightly less accurate than their non-visual counterparts.

The highest mean score on the DAT (43.0) was obtained by the group which said that they could visualize clearly in their minds and that they also talked to themselves about the mental image they were forming. It may be that the use of not one but a combination of representational systems is the most effective strategy for solving spatial relations problems.

CHAPTER 5

Discussion

Bandler and Grinder's writings indicated that some people have one or more underdeveloped primary representational system and that they thus delete a part of their experience. Although their work considered the effect of such deletions on interpersonal communications, it seemed reasonable to assume that other aptitudes, in such areas as spatial relations, might also be affected by impoverished primary representational systems. If this were found to be true, then training in an underdeveloped system would be an important form of developmental education, permitting a person to more fully develop his or her potential.

The purpose of this study was, first, to attempt to classify grade 10 students according to their primary representational systems, working with an entire group rather than with individuals. The classifications were then compared to performance on a spatial relations test to determine whether a strong visual primary representational system was an asset when solving such problems. Secondly, the study attempted to develop one representational system -- the visual -- by visualization training done, once again, with an entire group. A second form of the same spatial relations test was given after the training to determine whether the students had improved in their ability to mentally manipulate objects. The group classification and training techniques were used to test the feasiblity of designing developmental education classes in the area of primary representational systems.

However, although the literature had supported the expectation that there would be a positive relationship between a visual primary representational system and higher scores on spatial relations tests, this was not indicated by the results of this study. An analysis of variance found that there was no significant difference between the arithmetic means of the visual and the non-visual groups on either the pretest or the posttest. A comparison of scores on the spatial relations test and scores on the <u>Learning Style Self Inventory</u>, the measure of preferred input system which was used to classify students by primary representational system, in fact produced a significant negative correlation between a preference for visual input and performance on the spatial test. In addition, the analysis indicated that the posttest arithmetic mean of the group which had received visualization training and that of the control group were not significantly different, and that there was no significant interaction between classification as visual or non-visual and membership in the control or experimental group.

What factors could have caused results so radically different from those which were expected? Although no obvious reasons stand out, a number of possibilities can be mentioned.

It may be that primary representational systems, as postulated by Bandler and Grinder, do not exist or at least do not have any connection to spatial relations ability. Even if they do, it may be impossible to strengthen the visual representational system by training.

On the other hand, the source of difficulty may lie in the method used to classify students by primary representational systems. Inaccurate classification was indeed suspected to be a cause of inconsistent results in many of the learning modality studies which were cited in the literature review. The questionnaire which attempted to elicit predicates and information on students' activities did not produce results which could validly be used to classify students by representational system, and the preferred input system indicated by students on the Learning Style Self Inventory may not reflect the primary representational system. If this were the case, the study would have measured input systems but attempted to train representational systems. This possibility is suggested by the negative correlation between membership in the visual group and higher scores on the spatial relations test. An examination of the LSSI statements which are considered to be visual reveals that only one of them — "When somebody is telling me about something, I can picture it in my mind" — concerns mental imagery. The others refer to looking at an object and gaining information from it. Furthermore, two of the statements might be answered positively more often by people who do not visualize well: they may state that "a story is easier to understand in a movie than in a book" and that they "like to read books that have pictures or drawings in them" precisely because they cannot readily form mental images of what they read. Although Bandler and Grinder imply that people with a visual primary representational system pay more attention to things that they see and gain their information this way, there may be a subtle difference between gaining information visually and representing it internally in visual terms. This would make a measure of input systems invalid for identifying representational systems. Perhaps the latter cannot be accurately identified by group instruments, but only by the observation of an individual's speech patterns and non-verbal behaviors in the course of an interview. This is what Bandler and Grinder have done in their work.

It is also possible that the original questionnaire would have been more effective with a group other than adolescents. Much of the difficulty with the incomplete sentences section of the questionnaire arose from the preponderance of kinesthetic predicates and activities in the responses. This imbalance did not appear when the pilot group of grade 11 and 12 students did the questionnaire. The grade 10's, at the age of 15, seemed to be very concerned with physical activities and with their emotions. Indeed, they may not yet have developed a true preference for one input or representational system.

A second possible cause of the negative results could be the design of the training sessions. Although the literature indicated that brief, specific training was most likely to be effective, the two sessions, comprising approximately 80 minutes, may not have been sufficient. The overlapping of representational systems which was used is a technique recommended by Bandler and Grinder, but, once again, they have used it with individuals and not with groups. It is possible that the instructions must be designed specifically for one person and must be guided by that person's feedback during the training in order to be effective.

Thirdly, the scores on the DAT Space Relations test may have been influenced by factors other than visualization ability. The students were not test-sophisticated and their performance might have been influenced by anxiety or confusion about the test. A trend to improvement in confidence and success was observed, in that virtually all of the students had higher scores on the posttest than on the pretest. In addition, more intelligent students might have compensated for poor visualization skills by logical reasoning, while less intelligent students might have been able to imagine the pattern moving but still not make a logical choice based on reasoning. Since space relations scores form part of a general reasoning score on many aptitude tests, a student's intelligence likely would affect the score, regardless of his or her visualization ability.

An attempt was made to compare the DAT scores with IQ scores, but insufficient data was available. Furthermore, since the group who did the best on the test was using a combination of visual and auditory representational systems, the use of visualization alone may not be the best strategy for solving spatial relations problems.

Finally, it is possible that the students in this study did not have truly impoverished representational systems even though one of their systems may have been stronger than the others. Bandler and Grinder's clients were experiencing difficulties in their lives because they had deleted a part of their experience; these students — not part of a group seeking counselling because of difficulties — might have had less-developed representational systems which were still strong enough to be functional. All but one of the students who did not have a "major" rating for visual input on the LSSI had a "minor" rather than a "negligible" rating for visual input. People with a very weak visual representational system might have shown improvement after similar visualization training.

The possibilities outlined above could well be examined in further research. A repetition of the experiment with a control for intelligence could produce useful information, as could a similar experiment with subjects whose visual representational systems were identified clinically as being truly underdeveloped. The study could also be replicated with an adult group, perhaps after exercises to reduce test anxiety.

In addition, two contrasting studies could help to clarify whether the negative results indicate a lack of connection between representational systems and spatial aptitudes, inadequate classification techniques, or inadequate training. One would use interviews with individual subjects for the identification of primary representational systems but group sessions for the visualization training; the other would use individual interviews for both the identification and training.

It had been hoped that this research would help to clarify some of the contradictions in the literature on learning modalities and visualization training, as well as to indicate new possibilities for the application of Neurolinguistic Programming theory in schools. What it has done is to identify a combination of techniques which have not been effective. Hopefully, future research will begin to clarify the reasons for the unexpected outcomes of this study and add to our understanding of primary representational systems and spatial relations aptitudes.

BIBLIOGRAPHY

Austin, Mary C., and Donovan, Margaret A. Does Modality Preference Make a Difference? The Results of a Three-Year Study -- Literature Review. May, 1978. (ERIC Document ED 157 026)

Bandler, Richard, and Grinder, John. Patterns of the Hypnotic Techniques of Milton H. Erickson, M.D., vol. I. Cupertino, California: Meta Publications, 1975.

Bennett, George K.; Seashore, Harold G.; and Wesman, Alexander G. Manual for the Differential Aptitude Tests, Fifth Edition, Forms S and T. New York: The Psychological Corporation, 1973.

Boffoly, Richard Lee. "A Factor Analysis of Visual, Kinesthetic and Cognitive Modes of Information Handling." Dissertation Abstracts International 35; 3-A (September 1974): 1489-90.

Bruner, Patricia Boyle. "The Effects of Perceived Parental Nurturance, Sex of Subject and Practice on Embedded Figures Test Performance." Dissertation Abstracts International 38; 8-B (February 1978): 3867-68.

Burcham, Temmie et al. "Effects of Auditory Reception on Auditory and Visual Learning Tasks." Education and Training of the Mentally Retarded 9; 2 (April 1977): 56-61.

Butzow, John W. and Schlenker, Richard M. A Study of a Possible Relationship Between Lowenfeld's Visual-Haptic Theory and Piaget's Developmental Theory. March, 1978. (ERIC Document ED 152 705)

Carpenter, Finley et al. Educability of Studies in the Visualization of Objects in Space. 1965. (ERIC Document ED 003 271)

Caukins, Sivan Eugene Jr. Teaching Reading -- Vision vs the Muscle Spindles (The Proprioceptors). 1971. (Eric Document ED 056 831)

Ciganko, Richard Allan. "The Effect of Spatial Information Training and Drawing Practice upon Spatial Visualization Ability and Representational Drawings of 9th Grade Students." Dissertation Abstracts International 34:6-A (December 1973): 3131-32.

Cohen, Donna. "Usefulness of the Group-Comparison Method to Demonstrate Sex Differences in Spatial Orientation and Spatial Visualization in Older Men and Women." Perceptual and Motor Skills 43; 2 (October 1976): 388-90.

Conner, Jane Marantz; Schackman, Maxine; and Serbin, Lisa A. "Sex-Related Differences in Response to Practice on a Visual -Spatial Test and Generalization to a Related Test." Child Development 49; 1 (1978): 24-29.

Conner, Jane Marantz; Serbin, Lisa A.; and Schackman, Maxine. "Sex Differences in Children's Response to Training on a Visual-Spatial Test." Developmental Psychology 13; 3 (1977): 293-94.

Cowles, James D. An Experimental Study of Visual Perceptual Training and Readiness Scores with Certain 1st Grade Children. February 1969. (ERIC Document ED 032 921)

Cox, M.V. "Perspective Ability: a Training Programme." Journal of Educational Research 71; 3 (January-February 1978): 127-33.

Darrow, James F. "Instruction Method Effects on Visualization Test and Visualization Task Performance by Non-Art Elementary Majors." Dissertation Abstracts International 33; A (1973): 6725.

Donovan, Margaret A., and Austin, Mary C. Does Modality Preference Make a Difference? The Results of A Three-Year Study — Empirical Data. May 1978. (ERIC Document ED 157 027)

Dorethy, Rex E. Art Education and Perceptual Theory: a Critical Analysis. November 1975. (ERIC Document ED 147 266)

Eastman, Phillip M., and Salhab, Mohammed. "The Interaction of Spatial Visualization and General Reasoning Abilities with Instructional Treatment on Absolute Value Equations." Journal for Research in Mathematics Education 9; 2 (March 1978): 152-54.

Egeland, Byron et al. Visual Information Processing: Evaluation of a Training Program for Children With Learning Disabilities. 1976. (ERIC Document ED 132 161)

Eliot, John, and Fralley, Jacqueline S. "Sex Differences in Spatial Abilities." Young Children 31; 6 (September 1976): 487-98.

Elkind, David, and Deblinger, Jo Ann. Reading Achievement in Disadvantaged Children as a Consequence of Non-Verbal Perceptual Training. 1968. (ERIC Document ED 021 7o4)

Frederickson, Edward W. Shape Perception Judgements as a Function of Stimulus Orientation, Stimulus Background, and Perceptual Style. December 1970. (ERIC Document ED 049 496)

Glover, Henry. "A Study of the Relationship Between Scores on a Visualization Test and Neural Impulse on a Visual Task." Dissertation Abstracts International 35; 3-A (September 1974): 1497.

Grinder, John; Delozier, Judith; and Bandler, Richard. Patterns of the Hypnotic Techniques of Milton H. Erickson, M.D., vol. II. Cupertino, California: Meta Publications, 1977.

Hartsough, Ross, and Laffal, Julius. "Content Analysis of Scientific Writings." Journal of General Psychology 83 (October 1970): 193-206.

Hewick, Walter Elton. "A Study to Compare the Effectiveness of the Differential Aptitude Tests and the Adapted Guyanese Tests for Identifying Aptitudes among Students in Guyanese Secondary Schools." Dissertation Abstracts International 30; A (1969): 3635.

Hopkins, Kenneth D., and Glass, Gene V. Basic Statistics for the Behavioral Sciences. Englewood Cliffs, N.J.: Prentice-Hall, 1978.

Janssen, David Rainsford. "Effects of Visual and Auditory Perceptual Aptitudes and Letter Descrimination Pretraining on Word Recognition." Dissertation Abstracts International 34; 3-A (September 1973): 1130.

Kagan, Jerome, and Kogan, Nathan. "Individual Variation in Cognitive Processes." In Carmichael's Manual of Child Psychology. 3rd Edition. Edited by Paul Mussen. New York: John Wiley and Sons, 1970.

Leibovitz, Perry London; Cooper, Leslie M.; and Hart, Joseph T. "Dominance in Mental Imagery." Educational and Psychological Measurement 32; 3 (Autumn 1972): 679-703.

Lindgren, Scott David. "Spatial Perception in Children: Supramodal Spatial Ability and Hemispheric Specialization for Spatial Processing." Dissertation Abstracts International 39; 1-B (July 1978): 388.

Lolla, Raymond Samuel. "The Effect of Selected Instruction in Tactual-Visual Perception on Ninth Grade Male and Female's Visual Imagery, Mechanical Reasoning, and Spatial Relations Abilities." Ph. D. Dissertation, Purdue University, 1973.

Lovgren, George K. "Sustaining and Encouraging Visual Imagery in Children Prior to Learning to Read." Reading Improvement 14; 4: 268-74.

Lowenfeld, Viktor. "Tests for Visual and Haptical Aptitudes." American Journal of Psychology 58 (1945): 100-112.

Marcus, Lee. "How Teachers View Student Learning Styles." NASSP Bulletin 6; 408 (April 1977): 112-14.

Marmor, Gloria Strauss, and Zaback, Larry A. "Mental Rotation by the Blind: Does Mental Rotation Depend on Visual Imagery?" Journal of Experimental Psychology: Human Perception and Performance 2; 4 (November 1976): 515-21.

Millar, Suzanna. "Spatial Representation by Blind and Sighted Children." Journal of Experimental and Child Psychology 21; 3 (June 1976): 460-79.

Miller, Jack W., and Miller, Haroldine G. "Toward Resolution of the Spatial Puzzle." Peabody Journal of Education 54; 3 (April 1977): 135-41.

Mitchelmore, Michael C. "Cross-Cultural Research on Concepts of Space and Geometry." In Space and Geometry. Papers from a Research Workshop. Edited by J. Larry Martin and David A. Bradbard. August, 1976. (ERIC Document ED 132 033)

Morency, Anne. Auditory Modality -- Research and Practice. May 1967. (ERIC Document ED 014 383)

Newcomer, Phyllis L., and Goodman, Libby. "Effects of Modality of Instruction on the Learning of Meaningful and Non-Meaningful Material by Auditory and Visual Learners." Journal of Special Education 9; 3 (1975): 261-68.

Patridge, Susan. Modes of Learning. 1976. (ERIC Document ED 147 776)

Peterson, M. J. "The Retention of Imagined and Seen Spatial Matrices." Cognitive Psychology 7; 2 (April 1975): 181-93.

Pfleger, Lawrence R., and Pulvino, Charles J. How do Students Prefer to Learn? 1977. (ERIC Document ED 148 768)

Priddle, Ruth E., and Rubin, Kenneth H. "A Comparison of Two Methods for the Training of Spatial Cognition." Merrill-Palmer Quarterly 23; 1 (1977): 57-65.

Psychological Corporation. "What is an Aptitude?" Test Service Bulletin 36 (August 1948). (ERIC Document ED 078 026)

Rawls, Rachel F. Training in Visual Perception for Young Deaf Children to Stimulate School Readiness. February 1967. (ERIC Document ED 012 993)

Resnick, Robert J. An Investigation of the Modifiability of Visual Integrative Abilities in Children. June 1968. (ERIC Document ED 017 009)

Satterly, David J. "Cognitive Styles, Spatial Ability, and School Achievement." Journal of Educational Psychology 68; 1 (February 1976): 36-42.

Schlenker, Richard M. Viktor Lowenfeld's Visual-Haptic Continuum and Groups of Wide Geographic Separation. (ERIC Document ED 133 359)

Schlenker, Richard M. Viktor Lowenfeld's Visual-Haptic Continuum in Grades 9, 10, and 11. (ERIC Document ED 128 413)

Schroth, Marvin L. "Spatial Aptitude and Its Relationship to Art Judgement." Perceptual and Motor Skills 24 (1967): 746.

Segal, Ruth C. "The Haptic Approach in Practice." Academic Therapy 12; 2 (Winter 1976-77): 219-24.

Serapiglia, Theresa. "Self-Selected and Teacher-Matched Word Recognition Tasks Presented to Measured Perceptual Modalities of Primary Children." Dissertation Abstracts International 35; 3-A (September 1974): 1536-37.

Snow, Richard E. An Overview of Current Research on Aptitude Processes. August 1977. (ERIC Document ED 148 977)

Snow, Richard E. Research on Aptitudes: A Progress Report. Stanford University Research Project, Technical Report No. 1, September, 1976. (ERIC Document ED 141 721)

Taschow, Horst G. _Using the Visual-Auditory-Kinesthetic-Tactile Technique to Solve Spelling Problems in Elementary and Secondary School Classrooms_. December 1970. (ERIC Document ED 046 668)

Tuckman, Bruce W. _Conducting Educational Research_. 2nd ed. New York: Harcourt Brace Jovanovich, 1978.

Wiederholt, J. Lee, and Hammill, Donald D. "Use of the Frostig-Horne Visual Perception Program in the Urban School." _Psychology in the Schools_ 8; 3 (1971): 268-74.

Waugh, Ruth. _Modality Preference as a Function of Reading Achievement_. August, 1971. (ERIC Document ED 054 921)

Williams, Tannis MacBeth, and Aiken, Leona S. "Development of Pattern Classification: Auditory-Visual Equivalence in the Use of Prototypes." _Developmental Psychology_ 13; 3 (1977): 198-204.

Witkin, Herman A. "A Cognitive Style Approach to Cross Cultural Research." _International Journal of Psychology_ 2; 4 (1967): 233-50.

Wickless, Barbara Jeanette. "The Development of a Test of Spatial Perception to Assess the Spatial Ability of 8th, 9th, and 10th Grade Students." _Dissertation Abstracts International_ 34; 12-A (June 1974): 7475.

APPENDIX A

Script of The Visualization Training Sessions

First Day

We all get information through our five senses. For learning, we use mostly our visual, auditory, and kinesthetic systems. Everybody comes to depend a bit more on one of the systems, because we've learned that that works for us. It becomes stronger. For example, some of you would probably rather get information by reading a book, others by hearing someone tell them about it. Some of you would probably rather figure something out by looking at a diagram, others by actually picking the thing up and examining how it's put together. This is quite normal, just as some people prefer different foods and so on.

We may get information through one system, but react internally in another system which is stronger for us. For example, you see the expression on someone's face and that gives you a particular feeling, and then you react on the basis of the feeling you have. Or you do some physical activity that someone has warned you against, and you get a pain, and you can hear that person's voice in your head, warning you. You may also hear a voice and get a visual image of the person it belongs to.

The test you did needs a visual ability -- you try to use your visual system to create a picture in your mind and have the picture clear enough that you can see it move and change position. What you're going to do in this group is to try to improve your scores on that type of test by practising seeing and moving objects in your imagination. By practice you could get better at doing spatial relations problems.

The rest of this period we'll be doing this practice. It will be like exercising your imaginations. Some of you may find it hard to see mental pictures or hear sounds, but this should get a bit easier as we go through the practice. Just try to follow the instructions the best you can.

I'll be asking you to see the route you take as you go home, so each of you will be seeing different images. Some of you may be walking, or getting on a bus, or riding in a car, and so on. Just make your own mental pictures and then try to do the things I tell you to do with the pictures you see.

Remember, when you see things in your mind, see them from your own point of view, as you would if you were actually there. Don't see yourself as a separate person.

You will probably find it easier to close your eyes so you are not distracted by things you see in this room.

This should be relaxing. Start by finding a comfortable position in your chair. Now take five deep, slow breaths.

It's the end of the day and you're about to go home from school. You're at your locker. You're putting things in the locker -- feel them in your hands, feel yourself reach up to the shelf. Feel yourself pick up anything you want to take with you, maybe put on a jacket. Now just try to see the inside of your locker for a minute. Look at what is in it and where things are.

Close the locker. Hear the sound it makes. Feel your fingers putting the lock in place and shutting it -- hear it snap shut. One of your friends is there and they start to talk to you. Hear their voice and what they say. Hear yourself answer them. Look at them. Listen to the other sounds in the hall. Now look around you and try to see everything as clearly as you can -- the hall, the lockers, the people standing around or moving.

Feel yourself walking through the halls. Feel yourself taking steps, your body moving. Look around and see the things that you are passing. Go towards the exit you normally use to leave the school. Listen to the sounds around you. Look and see where the sounds are coming from.

Go down the stairs. Feel yourself taking those steps. Look around you.

Now you're outside. You can feel that it's cooler. Listen to the sounds -- traffic, voices, some birds. Look around and see what things are making the sounds.

Turn back and look at the school. Try to really concentrate on the picture. Count the windows you can see, look at the doors -- are there windows in the doors? Are there bushes near the building? Watch the doors swing open and people come out. Now try to describe what you see in your mind, as though you were describing it to someone else. Hear yourself saying the words inside your head. Now just forget the words you used and concentrate on seeing the picture without talking to yourself.

Now continue along your normal route home. Feel the movement and listen to the sounds around you. Stop a minute. Listen. Look around you in all directions -- turn to your left and see what's there, then to your right, then behind you.

Now look at some object that's near you -- a pole, a bench, a car, a letterbox, a tree, a bike. Go over and touch it. Feel what it's like -- smooth or rough? Sticky? Dusty? Take a good look at it. Walk around and look at it from different angles and see what it's like from those sides.

Continue on your way. Feel the motion, feel any surface you are touching. If you are next to something, sitting on something, standing on something, be aware of the surface your body is in contact with. Look at those things.

There is another person there and they begin to talk. Hear their voice and your voice as you answer. Look at them. Try to form a clear image of what they look like. Watch what they're doing -- are they moving, changing their position? As they talk, see their lips move. Now try again to get a clear image of their face, their expression.

Continue on your way until you are very near to your home. Try to see the things you would see on that route. Look to your left and see the things you're passing... to the right... behind you....

Hear the sound of a truck. Turn and look at it. What does it look like? Is it big? What colour is it? Does it have any signs on it? Watch it approach, pass by you, and disappear.

Feel the steps you are taking. Look at something in the distance. As you feel yourself move towards it, see it get closer to you. It gets bigger and you can see more details as you move nearer to it. See those details.

Walk up to the front of your house or apartment building. Feel yourself make the turn to go towards it. Listen to any sounds you hear -- people talking, traffic, a dog barking, birds, children playing. Look around and see what is causing those sounds.

Now study the front of your house or building. See all the details you can. How many windows are there? Are they open or shut? Are the curtains open? What do they look like? How many steps are there? Can you see a chimney? Is the roof straight or does it have a peak? Now, in your mind, describe what you see to another person. Hear yourself saying the words. Now forget the words and just try to see the picture.

Now turn left and walk around to the left side of the building. Go around the corner and stand back a bit. See that side of it, in detail, and try to describe it in your mind. Now just see the picture.

Walk around to the back. Stand back, and try to see it clearly from that position. Describe it in your mind, then let the words disappear and just see the picture.

Go around to the other side. Take a look at that side. How would you describe it to someone? Now just concentrate on seeing the picture.

Imagine you were looking down on the top of the building from a higher building or a helicopter. Try to see what it would look like from there. Where is the peak of the roof? The chimney? Concentrate on seeing that picture.

Return to the front. Now walk up to the front door -- feel yourself going towards it, up or down any steps. Feel the doorknob in your hand and turn it. Open the door. Listen to the sound it makes. Walk in and shut it. Hear it click. Look around you.

Look for a small object you could pick up. If you don't see one, go a bit further into the room. Walk over to it and pick it up. Feel it -- feel its shape, if it is smooth or rough, if there are any bumps or sharp corners.

Look at the top, or at one side if there is no real top. Turn it over -- feel it turn in your hands -- and look at the bottom or the opposite side. Now turn it again and look at a different side. Find some other angle at which you haven't held it and turn it to look at it in that position. Now turn it back so the first side is up again. Put it down on the floor.

Pick up another object near you. Look at it from the top. In your mind, describe what the top looks like. Hear your words. Now forget the words and just look at it. Turn it over and look at the bottom. Describe it in your mind, and then just try to see it without thinking about the description. Now look at another side and, again, describe it to yourself. Let the words fade from your mind and just see the object there, as clearly as you can.

Put it down on the floor to the left of the first object and about a foot away from it. Look at the two objects. Now move the second object closer to the first, so it is only about six inches away. Look at them. Switch the two objects so the second one is now on the right and the first one on the left. Look at them carefully -- see how close they are together, which way they are facing -- so that if you had to put them down exactly the same way again later, you could.

Pick up a third object. Feel it carefully. Are there any bumps or grooves on the top side? Is it smooth? Describe it. Now just look at it and forget the description. Turn it upside down and feel that surface. Describe it to yourself, then just concentrate on seeing it.

Take it over to the other two objects and put it on the floor, closer to you than the other two are, but so that one of the other objects is to the left of this one and the other is to the right of it. Look at those three objects and see how they look in relation to each other. Now walk around them and see how they look from different positions. Go to one side and look at them. Which one is to the left now? Which is nearer to you? Now walk around further and again look at their positions. Which one is on the left now? Closer to you? Go on to the other side and look at them again. Now walk back to where you started and see the objects from that position.

As you look down, let the picture gradually fade from your mind. Become aware of the desk you are sitting in and the other people around you in the classroom. Open your eyes and see the classroom. Stretch a bit, take a deep breath, relax.

(3 minute break)

Once again, find a comfortable position, close your eyes, take five deep, slow breaths.

See a table. It is bare. You are going to place nine objects on the table. Along the left hand side, put an apple near the far edge, a banana in the centre, and an orange nearest to you. See them lined up along the left side. Down the centre, put a cup farthest from you, a plate in the centre, and a glass nearest to you. Along the right hand side, put a pen farthest from you, a ruler in the centre, and a book nearest to you.

Now look at the table. Look at the far edge and see the three objects beside each other — the apple, the cup, and the pen. Then look across the centre and see the banana on the left, the plate next to it, in the centre of the table, and the ruler next to it. Look at the row nearest you and see the orange on the left, then the glass, then the book.

Describe to yourself the three objects on the left of the table... on the right... in between. Describe the objects along each diagonal — from the left near corner to the right far corner and from the right near corner to the left far corner. Now forget the description in words and just try to see the table with all the objects on it. Try not to have any words in your mind at all.

Now walk around to the left side of the table and watch the objects as you do so. See them now from this new position. See which ones are on the left now, which ones are in the centre, which on the right. Which are in the farthest row? The nearest? When you have described it to yourself from this point of view, just try to see it clearly without thinking of the description.

Now walk around to your left again and see the position of the objects change as you move. As you look at the table now, which objects are closest to you? Farthest away? In the centre? On the left? On the right? Take a good look at the table and see the objects sitting there. Clear all the words from your mind and just see the table.

Once again, walk around to your left, watching the objects as you do so. See the objects, and where each one is from this position. Try to get a clear picture in your mind, without thinking of a description in words.

Now you are going to walk around the table very slowly but without stopping. As you move, you will look at the objects and their positions from where you are at that moment. Try to do that now. Try to see how the objects will seem to be on different sides of the table as you move.

Let the picture fade from your mind. Become aware of the desk you are in, the other people around you. Open your eyes, stretch, take a deep breath, and relax.

Second Day

After about twenty minutes today, you will be writing another form of the Spatial Relations test you did two weeks ago. Before then, we are going to spend some time practising visualization exercises again, so that your minds are prepared for the type of problem you'll be doing.

Get into a comfortable position, and close your eyes. Take five deep, slow breaths, and feel yourself relax.

See a small, square glass table. The glass is clear. We are going to place some objects on the table again. First pick up a stapler and feel it in your hand. Feel your arm reach out and put the stapler along the far edge, on the left. Hear the sound as it touches the table. Now pick up a paper clip and feel yourself put that in the centre along the far edge of the table. Now an eraser — put that in the far right hand corner. Now you will pick up and place some objects along the centre row. Feel each one as you pick it up; feel your arm reach out and hear the sound as you put it down. On the left, put a ring. Then put a watch in the centre, and a pair of eyeglasses on the right. Now you will pick up a folded kleenex and put it on the left along the nearest edge of the table. Take a toothbrush and place it in the centre, and a comb on the right.

Now look at the left hand edge of the table and see the three objects sitting there -- farthest from you, the stapler, then the ring in the centre, and the folded kleenex nearest to you.

Look along the centre. Starting at the farthest edge, you see the paper clip, then, in the centre, the watch, then, nearest to you, the toothbrush.

Look at the right hand edge and see the eraser farthest away, the eyeglasses in the centre, and the comb nearest you.

Now get a clear image of those objects in your mind. Try to see where they all are. Describe it in your mind and as you do so reach out and point to each one in turn. Then forget the description in words and just concentrate on seeing the table with the objects on it.

Now walk around to the left side of the table and see the objects from that position. See which ones are on the left... the right... nearest to you... farthest away. Describe it to yourself, reaching out and touching each object in order. Now forget the words and just see the image there in front of your eyes.

Now imagine that you are under the table looking up through the glass. You are still on the same side of the table, but you have slid down underneath it. How do the objects look from the underside? Which ones are now on your left? Your right? Look at each one in turn, and then try to see the whole group at once.

Still under the table, move around to your left. Look at the objects again and see what position each is in now.

Come up on that side of the table and look down at it. Describe to yourself the position of the objects now, and point to them as you do so. Then let the words disappear from your mind and just see the table with the objects on it.

Slowly walk around the table, looking at the objects and watching how their positions seem to change as you move. Try to keep the picture clear in your mind.

Now let that picture fade again, and gradually become aware of where you are and what is around you. Feel the chair you are sitting in and hear the other people in the room. Open your eyes, stretch, take a deep breath.

In the few minutes before we begin the test, practise moving objects in your mind on your own. This is what you could do yourself if you were going to write a Spatial Relations test for a job interview, or entrance to a training program. It is a way of preparing yourself for the test.

APPENDIX B

LEARNING STYLE

SELF INVENTORY

This assessment will allow us to identify the ways in which you learn.

In this assessment are a series of statements. After reading each statement, please respond by indicating one of the three categories on the answer sheet.

Circle the: U if you wish to respond, USUALLY

S if you wish to respond, SOMETIMES

R if you wish to respond, RARELY

There are no GOOD or BAD, RIGHT or WRONG selections. Your response should reflect YOUR OWN feelings and insights.

Although you will not be timed, do not ponder over any one statement for a long time.

INDICATE YOUR ANSWERS

ON THE SHEET PROVIDED

1. I can tell if something is wrong with a motor by listening to it run.

2. The tone of a speaker's voice adds meaning to their words.

3. I could feel the difference between wood and plastic by sliding my hand over it.

4. I can button my coat in the dark.

5. A story is easier to understand in a movie than in a book.

6. I like to read books that have pictures or drawings in them.

7. I can recognize who is on the phone just by listening to the voice for a few moments.

8. I can remember music well enough to recognize a "tune" the next time I hear it.

9. I rub my fingers over something to find out how smooth or rough it might be.

10. I like to use my hands when learning about something.

11. I choose clothes for the way they look on me or in pictures.

12. I feel I know a person better if I see a picture of them than if I read about them.

13. Noises bother me when I'm trying to read or talk to someone.

14. I am able to tell which instruments are playing at different times during a song.

15. I decide that my hair needs washing by the way it feels when I touch it.

16. I can tell a nickle from a dime with my fingers when I reach inside my pocket.

17. When somebody is telling me about something, I can picture it in my mind.

18. When I tune a radio, I use the numbers on the dial.

19. I can recognize people by hearing their footsteps.

20. I tune a radio by sound, not by the numbers on the dial.

21. I like to write with a pen or pencil that "feels comfortable".

22. I pick up and feel vegetables and fruit before eating them.

23. I can understand what is going on by looking at a picture.

24. I like it when someone shows me how to do something rather than to read or be told about it.

"Auditory" statements: 1,2,7,8,13,14,19,20

"Tactile" statements: 3,4,9,10,15,16,21,22

"Visual" statements: 5,6,11,12,17,18,23,24

APPENDIX C

QUESTIONNAIRE

A. Check the sentence which <u>best</u> describes the way you solved <u>most</u> of the problems on the Space Relations Test. Place a check by <u>one</u> choice.

1. In my mind, I could quite easily see the patterns move and form the correct shapes.

2. I talked to myself (for example, I might tell myself "The door has to go to the left of the window").

3. I had trouble imagining how the pattern would move to form the object, and I really would have liked to pick up the pattern and fold it. That is how I solve such problems.

B. Imagine that you are working at a job you enjoy. Which of these three settings would you <u>most</u> like to work in? (If you would like more than one, try to decide which would be more important to you.) Place a check mark beside your <u>one</u> choice.

1. The area is quiet and relaxing. Sometimes you can hear birds outside the windows. You can have your choice of music if you want it. You can sometimes hear the hum of other conversations, but this is not unpleasantly loud or distracting.

2. The area is well lit and decorated in cheerful, bright colours. The furniture is attractive and there are many pictures on the walls. From the window you can see the mountains.

3. The area is one where you feel comfortable and at home. There are deep carpets and soft furniture.

4. You can be physically active while you are working and you have a chance to take part in sports or exercise during your breaks.

C. Imagine that you are on an ideal holiday in the tropics. Which of these places would you rather be at? (If you like all of them, try to decide which features are more important to you.) Place a check mark beside your <u>one</u> choice.

1. You can lie on the beach and feel yourself totally relax, as the sun beats down on you. You can feel the warmth spreading right through you, but a soft breeze cools you enough so that you are comfortable. When you wish, you can swim in the warm waters or let the waves lap over you.

2. Lying beside the ocean with your eyes closed, you can hear the sound of the waves rolling in and breaking on the shore. The leaves rustle in the breeze. Nearby, tropical birds are calling and singing, and the sound of music can be heard from the village.

3. From your cabin, you look out over a stretch of white sand to the deep blue water beyond it, sparkling in the sun. Lush green palm trees stretch from the cabin to the shore. In the distance, blue-green mountains seem to rise majestically out of the water.

D. In Walt Disney-type movies and cartoons, animals are like people. If I had a chance to be an animal like that:

1. I would most want to be a _____ because _____

2. Most of all, I would hate to be a _____ because _____

3. Right now, I am most like a _____ because _____

E. Complete the following sentences in any way that is true for you:

1. The season I like best is _____ because _____

2. If I had one hour off school to do anything I wanted, I would _____

3. When I'm with my friends, I really like to _____

4. My greatest strength is _____

5. When I enter a new group, I _____

6. At night I like _____

7. My house ____

8. Motorcycles ____

F. Try to form a mental picture of your living room at home. See all the details as clearly as you can. When you have "looked at" this picture for a minute or so, check any statements below which were true for you while you had this mental picture. You may choose more than one response.

1. The picture was clear and in focus, almost like I was actually looking at the room.

2. The picture was a bit unclear, and I had trouble keeping it clearly in mind.

3. I talked to myself in my head, to help me get the picture right (for example, I might say to myself "The red chair is beside the T.V.")

4. I just "saw" the picture. I didn't talk to myself about it.