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The Measurement and Implications of Visual and Verbal Cognitive Styles

Dissertation

by

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ABSTRACT

The Measurement and Implications
of Visual and Verbal Cognitive Styles

This dissertation had two primary goals. The first was to develop a measure that clearly differentiates individuals having either a visual or a verbal cognitive style as a predominant mode. The second goal was to demonstrate the functional utility of discriminating these cognitive styles. Specifically, it was hypothesized that "visual" and "verbal" individuals would be differentially affected by the act of verbalizing on a reasoning task.

Visual individuals were defined as those who primarily use visual images or spatial representations in their thinking, for remembering, for solving problems, or for understanding complex ideas. Verbal individuals use words and phrases in similar situations.

Two primary methods were used to divide subjects into visual and verbal groups. First, a 68-item questionnaire was developed. After being administered to 361 college students and 77 older adults, this new instrument was factor analyzed. "Verbal thinking" and "visual thinking" emerged as the first two factors for each age group. Because visual and verbal cognitive styles were each

conceptualized as a predominance of one kind of thinking, a difference between the factors and therefore, a difference between the two types of thinking was used to determine the visual or verbal styles of individuals. Similar scores were created using the difference between two WAIS subtests: the Block Design and Vocabulary Tests. These were assumed to be representative of visual and verbal abilities, respectively.

To test the primary hypothesis, half (randomly selected) of the subjects were required to verbalize while attempting to solve Ravens Progressive Matrices. Visual and verbal subjects who verbalized were then compared to those who did not verbalize. The major hypothesis was strongly confirmed. The problem solving of verbal subjects was facilitated by the act of verbalizing whereas the problem solving of visual subjects was impaired by this intervention. There were no major sex or age differences.

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Chapter I

INTRODUCTION

This dissertation is an empirical investigation of visual and verbal thinking styles. Visual thinking involves the use of images and pictures to remember or solve problems, and visual images and spatial representations to understand complex ideas. In contrast, verbal thinking involves words and phrases rather than images or spatial relationships. Each type of thinking involves a complex set of operations and strategies and each is more suited to a particular range of situations.

In this dissertation, the conceptualization of "style" denotes a preferred mode of cognitive functioning. It refers to the habitual use of or reliance upon either visual or verbal strategies at times when either would be equally functional for the task at hand. It is important to note that no individual functions completely in one mode. A person who has a visual style of thinking will have verbal abilities and be capable of functioning in a verbal mode. Likewise, a person who has a verbal style of thinking will have visual and spatial capabilities. The concept of style denotes the extent to which one type of thinking dominates the other in a particular individual.

The predominance of a visual or verbal cognitive mode has been shown to affect cognitive habits, preferences for

particular strategies, and aptitudes for solving particular problems (Corballis, 1983; Hunt, 1978, 1983; Paivio, 1971; Segalowitz, 1983). Attempts have been made to determine which people have one or the other type of thinking as a predominant mode (Paivio, 1971, 1978; Gazzaniga & LeDoux, 1978; Richardson, 1977). Additional research has investigated which cognitive style is more highly correlated with performance on particular tasks (Beaumont, 1982; Bradshaw & Nettleton, 1981; Hecaen & Albert, 1978; Hunt, 1980). However, despite the extensive study of many issues, researchers have not yet developed an adequate measure that clearly differentiates the cognitive styles. Furthermore, researchers have only begun to consider the role these styles play in explaining other behaviors -- such as the potential of these cognitive styles in helping explain how more "visual" and more "verbal" individuals respond differently to particular types of experimental manipulation.

This dissertation has two primary goals. The first is to develop a method for operationalizing the concept of visual and verbal cognitive styles; that is, to develop a measure that clearly differentiates individuals having either a visual or a verbal style as a predominant mode. The second goal is to demonstrate the functional utility of discriminating these cognitive styles.

Cognitive Styles

In this study, cognitive "style" refers to the relative dominance of visual and verbal thinking in an

individual. For example, a person with a verbal cognitive style would have stronger or more frequent verbal approaches to thinking and problem-solving than visual or spatial approaches.

There are several notions concerning the conceptualization of cognitive style that must be clearly specified. The first is the relationship between cognitive style and cognitive abilities. A reliance on one type of thinking involves the habitual exercise of a set of abilities, and most likely, this cognitive preference would be reflected in a relatively stronger development of these abilities than those abilities that are rarely used. In this vein, Witkin and Goodenough (1981) state that cognitive styles affect the development of ability patterns. As they explained, "cognitive styles are conceived to express themselves in these abilities, and accordingly, these abilities may serve as means for the assessment of cognitive styles" (p.60).

Although a cognitive style can be assessed by measuring abilities, it differs from abilities in an important way. In contrast to an ability, it is value-neutral. It does not have a clear "high" (good) and "low" (bad) end. Rather, each cognitive style has qualities that are adaptive in particular circumstances. In other words, neither a visual nor a verbal cognitive style is better. Each has advantages and disadvantages in different situations.

The next notion concerns the measurement of cognitive style. Because the conceptualization of cognitive style in this study refers to the balance of two kinds of thinking, it will be operationalized as the difference between two measures of self-reported tendencies. Because it is expected to be related to abilities, it is also operationalized as the disparity between measures of two kinds of abilities. These measures will be more fully described later.

It is important to note that an individual's cognitive style is not necessarily an indicator of scores on tests of visual or verbal abilities. For example, it might be expected that a person with a visual cognitive style would have higher scores on tasks involving visuo-spatial abilities than tasks using verbal abilities. But his or her visual abilities may not be higher than average. In addition, a person with a strong visual style, would not necessarily have low verbal abilities. Style refers to a preference, and not everyone has one. (According to some research, approximately 25% of the population is strongly identified with each style [Richardson, 1977].)

The third notion concerns the distinction between the terms "visual", "spatial" and "visuo-spatial". Much thinking that uses visual images is reported by researchers to involve spatial abilities (MacLeod, Hunt & Matthews, 1978). In the same way that verbal thinking involves the use of words and linguistic structures, visual thinking uses images and spatial relations. Thus, the abilities

associated with visual thinking are variously called visual, spatial, and visuospatial. The distinctions between them are subtle, and they are often used interchangeably. In this dissertation, calling the style "visual" reflects a personal decision; and all three terms for the associated abilities are used.

In this chapter, the history of research on visual and verbal thinking is reviewed and the relationship of visual and verbal thinking to various theoretical and empirical approaches to the study of cognition is discussed. The rationale and hypotheses for this study are then presented.

History and Perspective on Visual and Verbal Thinking

Theories about thinking have revolved around two main traditions: the Symbolist position and the Conceptualist position (Kaufman, 1980). Within the Symbolist position, thought is conceived of as being inseparably tied to symbols, and symbols serve as the media of thought. Symbols can be words, images, physical representations or gestures. According to Weisberg (1980), the need for symbols for thought derives from the notion that human thinking is "concerned with things 'out in the world.' Therefore, in order to think about some object, one must be able to bring that object 'inside.' Something must serve as the object of thought, to be contemplated and

manipulated" (p. 144).

In contrast, the Conceptualist position holds that while thinking may occur with the use of symbols, not all of our thinking is materialized in symbols. Within this framework, thinking is seen as a special type of cognitive activity involving mental entities of a special type, variously described as 'concepts,' 'schemata,' 'abstract ideas,' or 'propositional structures'. Words and images are mainly regarded as products of thinking and are assigned mere auxiliary functions. (Kaufman, p.13). Thus, thinking can occur in the absence of symbols. The clearest example is William James concept of the stream of thought (1890, p. 239). Images and words of importance are conceived of as being related to the resting place of thought, but it is the stream and relational aspects that matter.

Although it is generally agreed that there is some validity to both perspectives, cognitive research has predominantly followed the Symbolist tradition. This is understandable since this position offers concepts which are more easily and immediately translatable into empirical research. The present study follows this same tradition.

A further distinction developed within the Symbolist tradition between the Imagist and Linguist perspectives. Although it was agreed that symbols are used as "objects of thought" and are manipulated by individuals in their thinking, scholars disagreed as to whether the word or the image

was the "primary" symbol. According to 'linguists', thinking was "talking to one's self; words were the medium of thought, and without words, thinking, for the most part, would not occur, or would be impoverished" (Kaufman, 1980, p. 13). In contrast, for 'Imagists', "thinking is linked to reality through imagery, and even though verbal thinking does occur, it has to be translatable into imagery in order to be understandable and meaningful" (Kaufman, 1980, p. 14).

There is some controversy regarding the nature of these images. "Analogic" psychologists (e.g. Paivio, 1971, Kosslyn, 1981) argue that visual images are similar to mental pictures of objects, scenes or events, which can be expanded, scanned, rotated, brought into focus, transformed, etc. In contrast, "propositionalist" psychologists (e.g. Pylyshyn, 1973, Anderson & Bower, 1973) assert that images are "strings of symbols that correspond to propositions" (Johnson-Laird, p.147). They are logical abstract representations (which can be stored as pictures or words) and depend on the tacit knowledge and beliefs of a person. Anderson (1978) discussed the difficulties in specifying the nature of mental representations.

Although recent research and theory acknowledge the importance of both visual and verbal thinking, much research has attempted to divide thinking into categories according to the nature of the symbols underlying cognitive processes. Although varying tremendously in the content

areas, descriptions and methods, the dichotomies usually correspond to the Linguist and Imagist positions in that one focuses primarily on words as the most significant symbol, and the other emphasizes images or spatial representations.

Empirical support for the behavioral relevance of these two types of thinking comes from many different sources. The methods and approaches taken in this aspect of the study of cognition are presented in the following literature review.

The first section of this review presents a theoretical description of the verbal nature of thought. In the second section visual thought is described, in part, through the evidence of introspective accounts. The third section reviews empirical studies involving cerebral lateralization. Studies of lesions, "split brains", differential EEG activation, dichotic listening, evoked potentials and lateral eye movements are discussed. A fourth section presents research supporting the contention that individuals can be classified by cognitive 'type' -- with habitual patterns or preferences for one of the two modes of thinking. A concluding section discusses some miscellaneous approaches including studies on parallel/ sequential processing, the sentence verification paradigm, mediational strategies, and measures recently developed which attempt to discern 'visual' and 'verbal' thinkers.

What is Verbal Thinking?

Several important notions about the nature of verbal thinking consistently appear in the work of most of the major theorists (Kaufman, 1980; Luria, 1966a,b, 1981; Vygotsky, 1962; Weisberg, 1980). One major conceptualization is that speech and language serve as a directive function for thought. Vygotsky (1962), Piaget (1976), and Meichenbaum (1967, 1971a,b, 1972, 1973,), among others, have discussed the development and role of private speech in thinking. These theorists believe that thought is internalized language. As a person develops, there is a progression from egocentric non-directed talk to instrumental speech (which is more directive), to the internalization of speech, which is then used as the medium of thought (Bruner, 1964; Piaget, 1954; Weisberg, 1980). Language develops by taking on an instrumental role, both in getting what individuals need and want from others, and by regulating individual behavior (Piaget, 1954; Vygotsky, 1962). It enables the thinker to produce self-instructions which direct verbal and nonverbal activities (Meichenbaum & Goodman, 1977; Weisberg, 1980). Any overt response is assumed to be based upon prior formulation of a verbalization, usually a description of what will be done (Meichenbaum, 1977). In this conceptualization, the internalized linguistic structures become the basic structure of thought (Vygotsky, 1962).

According to some Russian theorists (e.g. Luria, 1959, 1961, 1981; Sokolov, 1972; Vygotsky, 1962), language

becomes directive in other ways. They assume that thought is dependent on language or, more specifically, covert speech. According to this perspective, verbal thought involves real articulation, and the feedback from the speech muscles serves to link successive verbal thoughts together (Kaufman, 1980; Luria, 1966, 1981; Solokov, 1972; Vygotsky, 1962; Weisberg, 1980). In other words, feedback from the inner speech musculature is necessary for inner speech to occur. The kinesthetic impulses from the speech musculature direct or select the ideas that are aroused while a problem is thought about (Sokolov, 1972; Vygotsky, 1962). At the same time, speech allows overt movements of other sorts to be inhibited, and speaking becomes a substitute for behavior (Vygotsky, 1962; Luria, 1966). Feedback from the speech muscles also serves to initiate those motor responses under the control of verbal thought. Thus, speech serves to direct other nonverbal activities as well (Weisberg, 1980).

Luria (1966) distinguishes between the semantic, syntactic, and directive functions of language. The directive function of language is characterized as consisting of words that give rise to new temporal connections in the brain and thus direct the action system. The syntactic function involves deep structure and the rules we have for organizing concepts. The semantic function involves the words we learn, and the corresponding concepts, objects and meanings which give content to our

thought.

Luria's semantic function ties in to the notion that thought is dependent on language. Sokolov (1972) and Vygotsky (1962) tend to agree that thought develops according to the nature of the language that is internalized. The learning of words results both in the acquisition of a new set of concepts and in new ways of organizing the external environment. Thus, the things we think about are assumed to change when we learn a language.

What is Visual Thinking?

In contrast to the "language is thought" perspective is the notion of visual thinking which also has a long history in philosophy and psychology. The extreme statement of this position alleges that "all human thinking depends upon the capacity to experience images" (Weisberg, 1980, p. 173).

Introspective data probably "provide the most intuitively compelling evidence for the existence of a picturelike image code and for the distinction between this code and a verbal code" (Anderson, 1978, p. 259). The following self-reported account of his thought processes by Albert Einstein is an eloquent description of visual thinking:

> The words of the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The psychical entities which serve as elements in thought are certain signs and more or less clear images which can be "voluntarily" reproduced and combined...This combinatory play

> seems to be the essential feature in productive thought - before there is any connection with logical construction in words or other kinds of signs which can be communicated to others. The above mentioned elements are, in my case, of visual and some of muscular type. Conventional words or other signs have to be sought for laboriously only in a secondary stage, when the above mentioned associative play is sufficiently established and can be reproduced at will. (Einstein, cited in Hadamard, 1949)

That "thought is language" may be true for some people, but certainly it is not true for all people. The writer Vladimir Nabokov, was asked in an interview the following question: "You have said that you think like a genius, write like a distinguished author, and speak like a child. Can you confirm the implication that your writing is unequal to your thought" (Saturday Review, 1976)? His response was:

> What I really meant and could not quite express was that I think not in words but in images, in swimming colors, in shaded shapes - a type of cogitation that used to be termed "cold delirium" by psychiatrists in old Russia. The feeling of power that I experience in my inmost self, among the delights of an abnormal mind, fades away when I speak or write. You are free to contradict me but I maintain that my English is a timid and unreliable witness to the marvelous and sometimes monstrous images I try to describe.

Although visual thinking cannot be "explained" as easily as verbal thinking, several people have attempted theoretical descriptions of how or why this visual thinking is believed to occur. Berkeley (1710) said that we can attend to only the relevant aspects of either the diagram in front of us, or to the image "in our heads". Mental

images are the "primary symbols of thinking, while all other symbols are secondary and derived from images. Among the secondary symbols, words are the most important. Words have meaning, but only indirectly, in relation to images" (1952, p. 410). A similar perspective comes from Price (1959). According to his theory, we use visual images in the same way that we use maps or sketch-plans. When someone asks us a question about something, we refer to this mental map and read off the answer.

A different perspective is presented by Polivanova (1974). "Visual operations predominate in problem solving processes and play a role equal to that of the logical and analytical processes. Visual components of problem solving interact with the processes of logic and serve the heuristic function of narrowing down the region of search and of formulating hypotheses that give direction to the search process" (p. 10878). According to Polivanova, attention to these visual aspects allows the "simultaneous reckoning of a number of simpler elements which, taken alone, do not guarantee a successful solution to the problem" (p.51). A position similar to Polivanova's is presented by Kaufman (1980). In discussing the uses of imagery, he says that imagery "furnishes material for working out the problem. It holds the meaning of a problem, and it fixes its essential parts in some way in order to solve it" (p.130).

A quote from George Orwell, who has some understanding of both visual and verbal thinking, demonstrates the

perspective of Kaufman and Polivanova.

> In prose, the worst thing one can do with words is to surrender to them. When you think of a concrete object, you think wordlessly, and then, if you want to describe the thing you have been visualizing, you probably hunt about till you find the exact words that seem to fit it. When you think of something abstract you are more inclined to use words from the start, and unless you make a conscious effort to prevent it, the existing dialect will come rushing in and do the job for you, at the expense of blurring or even changing your meaning. Probably it is better to put off using words as long as possible and get one's meaning clear as one can through pictures or sensations. (1956, p.49)

In contrast to the above descriptions of visual thought, the following quote from Aldous Huxley (1959) shows that creative and highly imaginative thinking can take place without much visual imagery:

> I am, and for as long as I can remember, I have always been a poor visualizer. Words, even the pregnant words of poets, do not evoke pictures in my mind. No hypnogogic visions greet me on the verge of sleep. When I recall something, the memory does not present itself to me as a vividly seen event or object. By an effort of the will, I can evoke a not very vivid image of what happened yesterday afternoon. . .But such images have little substance and absolutely no autonomous life of their own. . .Only when I have a high temperature do my mental images come to independent life. To those in whom the faculty of visualization is strong my inner world must seem curiously drab, limited, and uninteresting."

Different Perspectives on Visual Thinking

As the above examples demonstrate, the experiences of strong imagers seem an "indissoluble, and a very personal part of their mental life. For those who have no, or only

weak, images, there is the puzzle of what it can be that the others are experiencing" (Radford & Burton, 1974, p. 283). This attitude is manifested in the argument that "images are by their very nature specific, and images cannot serve as the general symbols on which human thought depends" (Fodor, 1975, p. 171). Indeed, non-picture imagers tend to be the doubters of imagery theory. For example, Fodor claims that there is "no reason to suppose that the best representation to account for verbal reports of picture-like properties of an image is a picture" (p. 180). In addition, he says that "the trouble is precisely that icons are insufficiently abstract to be the vehicles of truth. Pictures aren't the kind of things that can have truth values (p.181). Theorists such as these are neither aware of the potential analogic nor the potential propositional nature of images that were described earlier.

In contrast, Price discusses generic images that can refer to a whole class, or genus, of objects, (for example, an image of a person without any specific facial or bodily features). Indeed, the introspective descriptions of thought by Einstein, and the following by Titchener disprove the notion that images cannot be abstract - at least for some individuals:

> When I read or hear that somebody has done something modestly, or gravely, or proudly, or humbly, or courteously, I see a visual hint of the modesty, or gravity or pride or humility or courtesy. . .Meaning in general is represented in my consciousness by another of these impressionist pictures. I see meaning as the blue-gray top of a kind of scoop, which has a bit of yellow above it

> (probably a part of the handle), and which is just digging into a dark mass of what appears to be plastic material. I am sure that others have similar images. The various visual images, which I have referred to as possible vehicles of logical meaning, oftentimes share their task with kinesthesis. Not only do I see gravity and modestly and pride and courtesy and stateliness, but I feel them or act them in the mind's muscles (Titchener, 1909, cited in Mandler and Mandler, 1964, p. 167.)

Most imagery theorists do not base their position entirely on introspective evidence. Rather they produce experimental evidence to support their position (Anderson, 1978; Paivio, 1971), some of which derives from lateralization research.

Lateralization of Function

Research on cerebral lateralization provides physiological data suggesting that the two sides of the brain are specialized for different kinds of thinking. It should be noted that although much of this research on lateralization suffers from problems in methodology (which will be discussed only minimally), one of its most important contributions is in supporting the hypothesis that these two kinds of thinking can be empirically differentiated.

Three major approaches have been used to study lateralization of function. The first approach compares groups of unilaterally brain-damaged patients. The second uses patients in whom, in order to control epilepsy, the major neural connections between the two hemispheres have been severed. The third uses normal subjects and compares the activation on the right and left sides of the brain while

the subjects perform various kinds of tasks.

Lesion Studies

The earliest evidence for hemispheric differentiation and its relationship to the dual nature of thought comes from experiments showing selective loss of abilities with damage to one of the two hemispheres. Through a myriad of studies spanning several decades (e.g. Arrigoni & Delinzi, 1964, Benten, 1968, Corballis, 1983; Kimura, 1963; Meier & French, 1965, Milner, 1965, 1971, 1978; Segalowitz, 1983), researchers have discovered the types of cognitive deficits and impairment that have been found to follow these lesions.

Based on these unilateral injuries, damage to the left hemisphere has been generally associated with difficulties with various language skills, verbal memory, and linear, analytic or logical operations such as those involved in arithmetic, planning or organizing. In contrast, right hemisphere injuries have been associated with problems in visual perception, and nonverbal activities such as spatial relationships, music, visual and tactile mazes. It is important to recognize the limitations of these data, however, and the methodological shortcomings of the studies. For example, it is virtually impossible to match exact size, location and etiology of lesions. In addition, it is impossible to attribute precise causal relationships just because a disorder and a lesion occur simultaneously.

The reader is referred to Nebes (1978), Zaidel (1983), Hellige (1983) or Kinsbourne, (1978), for extensive reviews and discussions of this work.

Although deficits are more commonly associated with lesions in a particular hemisphere, it is important to note that cerebral lateralization is relative rather than absolute (Corballis, 1983). While many researchers concur in the greater involvement of each hemisphere in various activities, the right hemisphere has been shown to be involved in language and logical activities just as the left hemisphere has been shown to be involved in spatial functions. Whenever complex cognitive activity occurs, both hemispheres are involved.

Split Brain Studies

"Split brain" research, provides strong evidence for specificity of function and has contributed immensely to the empirical understanding of visual and verbal thinking styles (Gazzaniga & Sperry, 1967). In an attempt to control seizures resulting from severe epilepsy, patients were subjected to commisurotomy: the severance of the corpus callosum, the fibers connecting the two halves of the brain. Because information could not cross between hemispheres as it normally does, researchers had a unique opportunity to study the hemispheric specialization in isolation (Bogen, 1981; Levy, 1972; Nebes, 1974; Sperry, Gazzaniga and Bogen 1969).

These "split brain" patients were tested with a special apparatus to insure that the various tasks were presented to only one hemisphere at a time. They found that not only were the two sides of the brain specialized for different kinds of information and responses, but the two sides seemed to have separate consciousnesses. More specifically, researchers established that each hemisphere functioned independently and was independently conscious. Because of the types of tasks each side was more specialized for, one, usually the left, has been categorized as primarily verbal and the other as primarily visual (Sperry, Gazzaniga and Bogen, 1969).

Care must be taken however, in making inferences from split-brain subjects to those with normal, intact brains. Split-brain subjects are not normal and they do not have normal brains. It is impossible to assess the direct effects of the epilepsy as well as the commisurotomy on the capabilities and the organization of the brain. In addition, as Milner (1978) points out, although the observed left-right differences are statistically significant, they are commonly small. It seems that most tasks can be done by either hemisphere, and most are done with both hemispheres simultaneously. There are important processing differences between the hemispheres however, and they tend to use different strategies and usually reflect unequal competence (Zaidel, 1983).

Studies using Non-impaired Individuals

The results of these lesion studies and split brain research raised the question of whether hemispheric specialization normally corresponds to distinct modes of thought. Attempts to answer this question generated many additional investigations.

Much of this research suggests that normal individuals exhibit two primary modes of processing information (Akins, 1982). The research also indicated that these modes correspond to differential activation of the two sides of the brain. Techniques to assess and quantify the functional asymmetry in normal individuals have included measurement of reaction times, EEG techniques, dichotic listening experiments, the study of evoked potentials, and contralateral eye movements.

For example, in normal subjects, behavioral experiments have shown the right and left hemispheres perform different kinds of tasks at different speeds (Filbey and Gazzaniga, 1969; Geffen, Bradshaw, & Nettleton, 1972; Klatzky & Atkinson, 1971; Rugg & Beaumont, 1978). Tasks that involve an important verbal component are performed better when presented to the right visual field (left hemisphere), whereas visual tasks are performed better when presented to the left visual field (right hemisphere).

Other researchers examined the differential activation of the two sides of the brain while subjects were involved in different kinds of cognitive tasks (Galin and Ornstein, 1972; McKee, Humphrey & McAdam, 1973; Nebes, 1974). They

claim that the left hemisphere is more activated during verbal processing of information, while the right hemisphere is more activated while subjects perform visual and spatial tasks (such as drawing cubes, or arranging blocks to match a design).

It should be noted, however, that much of this work is problematic. Although it is acknowledged that there are two kinds of thought, it is not clear that in an intact brain the two sides specialize as much as some studies suggest. Poor methodology in much of this work renders it inconclusive. The conditions surrounding the different tasks were not well controlled. For example, some tasks were not equated for motor output, stimulus input, or level of difficulty. When these variables were more tightly controlled, the cognitive differences significantly diminished (Gevins & Schaffer, 1980; Gevins, Zeitlin, Doyle, Schaffer, Yingling, Yeager, & Callaway, 1979). Still, with more controlled methodology, work of this kind is promising.

Dichotic listening experiments and evoked potential studies also suggest that the left cerebral hemisphere is more involved in verbal functioning and the right hemisphere is more specialized for nonverbal tasks. In these studies, stimuli are presented to both hemispheres simultaneously, and the response (either a physiological response indicating greater cerebral activity or a verbal response indicating stronger auditory reception) indicates

greater involvement of a particular hemisphere in that activity. Pick and Saltzman (1978) assert that "both auditory-evoked potentials and a right-ear advantage in dichotic-listening tasks implicated the left cerebral hemisphere in verbal functioning; similarly, right-hemisphere specialization was suggested for nonverbal tasks" (p. 1,).

Other studies that suggest a relationship between right or left hemisphere and type of thinking concern lateral eye movements. It is assumed that the left and right hemispheres deal with different kinds of material, or process information in different ways. It is known that each side of the brain controls both the opposite (contralateral) side of the body, and the opposite sides of both visual fields. Therefore, the premise in this research is that the direction of individual's gaze would react to the ("visual" or "verbal") nature of the question asked and reflect which side of the brain was more activated. A leftward gaze would reflect greater right-hemisphere involvement, and eye movement to the right would reflect greater involvement of the left-hemisphere. This empirical link between the direction of gaze and the type of question asked has been found by many researchers. (Bakan & Strayer, 1973; Day, 1964; Erlichman & Weinberger, 1978; Galin & Ornstein, 1974; Gur, 1975; Kinsbourne, 1972; Kocel, Galin, Ornstein & Merrin, 1972; Meskin & Singer, 1974; Tucker & Serb, 1978; Weiner & Erlichman, 1976). Ornstein & Merrin, 1972). However, the conclusions

in this research lack reliability because, as with the EEG work on differential hemispheric activation, the conditions were not precisely controlled. Still, the work does lend support for the differential activation of the two hemispheres for visual and verbal material.

General Characteristics of Types of Thought

Many researchers have provided global descriptions of the types of thought and their relation to cerebral specialization. For example, Sperry (1974) claims there are two modes of thinking, verbal and nonverbal, represented rather separately in left and right hemispheres. Zangwill (1967) has suggested propositional vs. visuo-spatial. Earlier, this dichotomy was referred to as verbal vs. visuo-spatial (Bogen and Gazzaniga, 1965).

According to Edwards (1979), the left side of the brain deals with logical representations of reality and communication with the external world. It deals with rapid changes in time and analyzes stimuli in terms of details and features. In contrast, the right hemisphere deals with simultaneous relationship and with the more global properties of patterns. Nebes (1974) describes the left hemisphere as being best at handling those tasks in which the stimuli are familiar, verbal in nature, or easily described or labelled verbally. He describes the right hemisphere as excelling in tasks that involve meaningless shapes which are too complex or similar to describe or

distinguish in words.

Other important differences between the hemispheres have been discussed. For example, Nebes (1974) emphasized that what most characterizes the hemispheres is not that they are specialized to work with different types of material, but that each hemisphere is specialized for a different cognitive style . The left is specialized for an analytic, logical mode for which words are an excellent tool, and the right hemisphere is specialized for a holistic, gestalt mode, which happens to be particularly suitable for understanding spatial relations and music. Similarly, Bogen (1981) claims that hemispheric differences are more usefully considered in terms of process specificity rather than material specificity. Levy (1972) says that there is a fundamental difference in the way the right and left hemisphere perceive things. When the task can be performed by either the left or the right hemisphere, the two hemispheres tend to accomplish the same task by characteristically different strategies.

There is research to support these notions. For example, a study by Patterson and Bradshaw (1975) found evidence that the right hemisphere performs gestalt, template-like operations on visual stimuli, whereas the left hemisphere is responsible for more analytic operations on visual stimuli. They found that what is important is not differential storage of visual information in the right and left hemisphere but a differential ability to perform certain types of operations. Similarly, Anderson and Bower

(1973) suggested that procedures, rather than data could be differentially stored.

Complex and controversial ideas have emerged as investigators have attempted to extend the implications of this research beyond the data (Nebes, 1974). Historically, many individuals have shown a tendency to divide intellectual faculties and mental organization into two types (Springer and Deutsch, 1981) and more recently, there have been attempts to superimpose many of the psychological, philosophical and spiritual dualisms on the anatomical and functional dichotomy of the brain. Many characteristics of the dichotomies correspond to the nature of the processes attributed to the two cerebral hemispheres. For example, verbal thinking has been described as sequential, objective, and analytic. Verbal thinking is technical: it analyzes problems through details and features, it counts, marks time, plans step-by-step procedures and makes rational statements based on logic. In contrast, visual thinking has been described as simultaneous, spatial, analogic, iconic, nonverbal, and intuitive. Visual thinking works with more global properties of patterns, and can be characterized by leaps of insight. It is more subjective, holistic and time-free. It can manipulate spatial patterns and relationships, and can understand complex relationships that may not be logical (Edwards, 1979; Galin & Ornstein, 1972; Springer and Deutsch, 1981).

Edwards (1979) talks generally about the two modes of information processing. She states that the many dualities of thinking have a real basis in the physiology of the human brain. In addition, Edwards says that because the "connecting fibers are intact in normal brains, we rarely experience at a conscious level conflicts revealed by the tests on split-brain patients" (1979, p. 35).

Other Psychological Research Suggesting 2 Types of Thinking

Other types of research, including studies on mediation, investigations using the sentence verification paradigm, and educational research uncovered additional manifestations of these cognitive styles. Research in these areas will be reviewed after I discuss the issue of parallel and sequential processing. Parallel and Sequential processing is an important dimension contributing to the understanding of different kinds of mediation, as well as other approaches to visual and verbal thinking.

Parallel and Sequential Processing

According to many researchers, the sequential/parallel dimension may be one of the most important dimensions differentiating the specialization of the two hemispheres (Bogen, 1969; Levy, 1974; Nebes, 1974; Neisser, 1967; Paivio, 1971; Paivio and Csapo, 1969). These terms derive from the information processing model (Simon, 1979) and relate to a difference in basic means of processing sensory input. According to this model, stimuli can be processed

either one at a time (sequential or serial processing), or simultaneously (holistic or parallel processing).

Anderson (1974), Neisser (1967), and Paivio (1971), among others, have suggested that information processing can occur in two alternative modes or systems. This distinction reflects a theoretical model which specifies that the left hemisphere tends to deal with rapid changes in time and to analyze stimuli in terms of details and features, whereas the right hemisphere deals with simultaneous relationships and with the more global properties of patterns. Paivio and Csapo (1969) argued that visual imagery functions primarily as a parallel processing system, whereas the verbal symbolic system is specialized for sequential processing. They further assert that verbal processes are crucial in sequential tasks that involve pictorial items but not in nonsequential tasks. Many others have proposed similar distinctions (Bogen, 1969; Neisser, 1963 and 1967). For example, Bogen emphasized that the "most important distinction between the left and right hemisphere modes is the extent to which a linear concept of time participates in the ordering of thought" (1969). Levy concurs, asserting that "the left hemisphere analyzes over time, whereas the right hemisphere synthesizes over space" (1972, p. 107).

Many studies have been performed to test these notions. Paivio (1971) found that subjects who use images have considerably more freedom in the order in which they

can report information that their images present, while subjects who use discursive forms of representation (for example, sentences) are relatively restricted regarding the order in which their information can be accessed. Similar results have been found in other studies (Haber, 1966; Nebes, 1974; Paivio, 1970, 1971). As Nebes described, one can measure reaction time in a visual search task and determine whether it lengthens with an increase in the number of items, as it should in serial processing, or is unchanged, as would be predicted in parallel processing (1974). The results of numerous studies reflect the expected differences.

Cohen (1972b) performed a different kind of study using a similar reaction-time paradigm. He found that verbal displays falling into the right-half field (left hemisphere) are processed serially, while those in the left-half field (right hemisphere) are processed in parallel. Cohen concluded that the most likely explanation for this dissimilarity in search strategies between the two hemispheres is that there are two different ways of treating language material -- verbally and visuospatially. Similar results were reported by Segalowitz (1983). As he described, the right hand (and left hemisphere) seems to prefer sequential detailed strategies while the left hand (and right hemisphere) prefers a more global tactic for identifying stimuli.

In sum, there is consistent support for the hypothesis that thought can be divided into parallel and sequential

dimensions. It should be noted, however, that although the distinction between serial and parallel processing is quite clear conceptually, Townsend (1974) claims it is impossible to tell from behavioral data whether serial or parallel processing is involved in any particular cognitive act. Any act that could be explained by one model is also explainable using the other model. In addition, as Shiffrin and Schneider (1977) assert, tasks which initially might require serial processing and greater attention become transformed with practice into automatic parallel processing. This is consistent with other lateralization research which indicates that after individuals practice tasks or become familiar with the demands and strategies, these tasks often get reassigned to the opposite hemisphere (Olson & Bialystok, 1983).

Mediation Resesarch

Mediation can be described as a mechanism, or as a symbolic system activated during the temporal period between an initiating stimulus and a terminal response. Application of this mechanism is assumed to be a reaction to the stimulus, and to have some effect on the response. It could include attending to or selecting certain features as being important (Anderson, 1974). According to Paivio (1971), when a subject uses mediators, he is taking advantage of pre-established representations or associative habits to construct a more meaningful (and

therefore more available) relationship between units. Simply put, mediation can be conceived of as "thinking". It is what is used or done (in one's mind) after encountering information (from internal or external sources) that leads one to yet another stage of processing that piece of information -- for example, making an association or a conclusion.

Types and Functions of Mediators

The existence of both visual and verbal types of mediation has been documented in a wide variety of studies (Huttenlocher, 1968; Paivio, Smythe, and Yuille, 1968; Paivio and Yuille, 1967; Polivanova, 1974; Reese, 1965). In describing the functions of these mediators, Paivio (1970) postulates that they may be relatively directly aroused in the sense that an object or an event is represented in memory as a perceptual image and a word is typified as a perceptual-motor trace. Or, says Paivio, mediators may be associatively aroused by an object eliciting its verbal label or images of other objects. Similarly, a word may arouse implicit verbal associations or images of objects.

Paivio (1971) discusses hundreds of studies concerning visual and verbal mediation, and the comparisons between differential effectiveness of the two systems. These mediation studies include memory studies, protocols involving paired associate learning, studies on recall, recognition, word association, parallel and sequential

memory, and experiments involving differences for concrete-abstract words, random shapes, and labeling.

Advantages and Disadvantages of each Type of Mediation

There are advantages and disadvantages of each kind of mediation. Paivio (1969) discusses three major factors which affect the availability or effectiveness of these symbolic systems in a given task. The first concerns the stimulus characteristics. For example, visual imagery is generally better for concrete information, whereas verbal mediation is better for abstract information (Paivio, 1967; Paivio et al., 1968). The sequential or spatial organization of the stimuli is another important characteristic. As discussed earlier, visual imagery (or mediation) is usually more efficient for processing parallel or spatial information, whereas the verbal symbolic system is particularly efficient for dealing with and storing sequential information (Anderson, 1974; Anderson & Bower, 1973; Paivio, 1971; Paivio and Csapo, 1969).

The second factor influencing the effectiveness of the mediators concerns the requirements of the situation, that is, the experimental manipulations, task instructions or various presentation and task demands. Imagery tends to be more useful in novel situations involving the simultaneous organization of information (Anderson, 1974; Paivio, 1971). Language is more useful in familiar situations involving the transfer between tasks, or in the processing of

sequentially organized information (Kaufman, 1980; Paivio, 1971). The differential effectiveness and availability of visual and verbal mediation systems has been used to explain many types of differences in performance.

Individual differences in the efficiency of and "preference" for particular modes of symbolic representation can also influence the differential effectiveness of the two kinds of mediation (Paivio, 1971). There are many mediation studies that have uncovered individual differences and preferences for particular symbolic modalities. For example, Paivio, Yuille and Smythe (1966) reported that people use either visual or verbal tricks to help them remember items. Others found that high and low imagers had very different ways of coding, remembering and storing information (Ernest & Paivio, 1971; Kuhlman, 1960; Paivio, 1969; Paivio, Rogers & Smythe, 1968; Stewart, 1977).

The idea that individuals might differentially rely on different kinds of thought suggested to some researchers the notion of types (Paivio, 1971). For example, Shaw (1919) gave word association tests and found that some people consistently responded with visual associations such as scenes, persons or objects "appearing" to them in visual images. Other subjects responded with verbal associations which included fewer nouns and more abstract concepts. Similar results were found by Davis (1932) and Paivio et al., 1968).

Sentence-Verification Paradigm

Hunt asserts that mental behavior "should be explained by identifying the processes involved in problem-solving, rather than by producing abstract descriptions of the outcome of thinking" (1983, p. 142). To this end, Hunt (1978, 1980, 1983) and Mathews, Hunt and Macleod (1980) performed extensive work in the field of cognitive strategies. This research attempted to understand the processes involved in cognition and focused on individual's choices of internal representations for problems. They also focused on subjects' strategies for manipulating the representation, and their abilities to execute particular information processing steps required by the strategy.

This research used the sentence verification paradigm, in which subjects verified the truth of simple sentences as descriptions of simple pictures. For example, subjects would be shown a phrase such as "plus above a star" and then had to verify whether a simple picture was correctly described by the phrase.

Analysis of the data from Hunt's studies (1978, 1980, 1983) and those of Mathews, Hunt and Macleod (1980) provided evidence that different individuals developed "characteristic ways of looking at sentence-picture comparisons, ways that call into force qualitatively different elementary information-processing steps" (Hunt, 1978, p. 136). Subjects adopted one of two strategies: They were classified as following a linguistic or a visual-imaginal model (Mathews et al., 1980). "Verbalizers"

memorized the phrase, described the picture to themselves, and then compared the description to the memorized sentence. "Imagers" read the sentence, generated an image of the expected picture, and compared the image to the percept. The two strategies produced striking differences in verification times (Hunt, 1983). Verification took longer for verbalizers, who had to translate the picture into words before making comparisons.

In addition, not only did Hunt and his associates find that "verbalizers" and "imagers" used very different strategies in problem solving, they also found that the best predictors of whether a subject would follow a pictorial model or a linguistic model were spatial abilities and verbal abilities scores from a previously taken SAT-like test (MacLeod, Hunt & Mathews, 1978). Here again, the evidence is suggestive of visual and verbal "types".

Contributions from Literature on Learning Disabilities and Psychology of Reading

Because educators must teach students with various styles, deficiencies and strengths, identifying the processes involved in individual learning takes on an immediacy that is not requisite in most psychological research. Educators must determine what works -- that is, those teaching strategies and instructional methods which are most effective given particular thinking and learning styles. As a result, not only have various approaches been

discovered (and applied), but types of deficiencies and styles of thinking have been discovered in the process (Cronbach & Snow, 1977; Hunt & Sullivan, 1974; Kaluger & Kolsen, 1978; Robeck, 1974).

Research in the fields of learning disabilities and psychology of reading strongly suggests that thinking can be divided along continua that approximate visual and verbal dimensions. For example, in his elaborate review of learning disabilities and teaching strategies, Lerner (1976) discusses two kinds of cognitive processing that can be observed -- "those that are independent of language formulations and linguistic meanings and those thinking skills that are part of the language process" (p.289). Many investigators have produced considerable evidence for the functional significance of both kinds of processes (Cronbach and Snow, 1977; Kolb, 1976; Ross, 1976). Lerner (1975) gives many examples of specific academic problems that "may reflect a disorder in nonverbal thinking, or verbal thinking, or both" (p. 289). Lerner also discusses various teaching strategies that are geared to different strengths and problems.

As most of this literature suggests, normal learning involves a variety of skills, inputs and processes. Ideally a learner is able to use each of the many skills in learning and problem solving, depending on the requirements of a particular situation. The normal child (without a learning disorder) "exhibits a relatively uniform pattern among these subskills, with small differences between best

and worst performances in various mental abilities" (Lerner, 1976, p.283). However, an uneven development among the various skills is ackowledged to have a positive relationship to learning disturbances. There have been many types of work substantiating this notion (Gallagher, 1966; Serifica & Sigel, 1970; Lerner, 1976).

Many studies examine particular learning styles and correlate them with different patterns of performance on WISC and WAIS subtests (Ackerman, Peters & Dykman, 1971; Anastasi, 1968; Bannatyne, 1974; Clements, Lehtinen & Lukens, 1964; Glasser & Zimmerman, 1967; Robeck & Wilson, 1974; Rugel, 1974; Serifica and Sigel, 1970; Lerner, 1976). Children with learning problems tend to show irregular abilities profiles on intelligence tests. In this manner, WAIS and WISC scales are useful in pointing out differential strengths and helping to diagnose particular deficiencies.

Studies testing perceptual modality have shown that many children develop strengths or preferences that allow them to function more effectively and to learn better through one mode (i.e., auditory) than another (i.e. visual) (Bakker, 1973; Kaluger & Kolson, 1978; Weintraub, Robinson, Smith & Plessas, 1971). As would be expected, children who learn poorly through a particular modality are likely to have difficulty with particular learning approaches (Lerner, 1976, p. 239). Accordingly, many techniques and strategies of teaching have been developed to accommodate students with particular preferences for

learning and processing information (Cronbach and Snow, 1977; Gibson, 1965; Gibson, & Levin, 1975; Lerner, 1976; Ross, 1976; Robeck, 1964). Educators realize that learning must be viewed not only by the features of the tasks to be learned, but also by the ways in which the students process information (Cronbach & Snow, 1977).

There exists a comprehensive literature on the teaching of reading and on analyzing the factors that comprise the ability to process written material. The nature of the various reading disabilities and numerous programs to improve reading skills are widely referenced (e.g. Cronbach & Snow, 1977; Kaluger & Kolson, 1978; Robeck, 1974; Gibson & Levin, 1975; Ross, 1976). Most reading research categorizes stimuli as auditory and visual, and some kinesthetic; educators interested in reading usually are concerned with the relative dominance of the different systems in an individual's learning (Robeck, 1974). Because reading requires a combination of visual and verbal skills to such a large degree, this literature contributes much to the understanding of visual and verbal abilities and their interaction in individuals.

In sum, cognitive "style" seems to be reflected in the tendency to develop different habits and patterns of learning. Being predominantly "visual" or "verbal" could be a result of strong development of one set of cognitive skills with a relative deficiency in other skills. The literature stresses the importance of identifying these patterns.

Cognitive Types

Some of the work discussed has already suggested the notion that individuals can be categorized into "types" of thinkers. Paivio (1971) reports that people are normally distributed in their symbolic habits and abilities, and that individuals can "fall at the extremes of the distribution with respect to the tendency and ability to engage in a particular form of symbolic activity" (p. 480). The following is a brief description of some other general approaches, and some physiological studies that support categorization of individuals into cognitive types.

General Approaches to Cognitive Types

Some of the earliest suggestions of cognitive types derive from studies in which people were asked how they think. Griffitts (1927) had people give verbal accounts of their thought processes after solving a variety of problems. He concluded that there were visual ("concrete") thinkers and verbal ("auditory-motor") thinkers. In a similar vein, Roe (1951) asked research scientists to describe the typical ways in which they conducted their thinking. Psychologists, anthropologists and lawyers emerged as verbalizers predominantly. As they reported, their typical mode of thought approximated talking to themselves. In contrast, biologists and experimental physicists were more likely to be visualizers and be conscious of "quasi-pictorial representation during their

thinking" (Roe, 1951, p. 469).

Bartlett's (1932) studies on perception and memory concluded that particular strategies are habitually employed by different types of subjects. For example, a person who relied upon visual cues in descriptive tasks also tended to use visual cues for memory tasks. Subjects relying more on verbal cues tended to do so for both types of tasks (relying on verbalizations and vocalizations instead of visual cues). Bartlett concluded that "the ways in which we deal with the various problems that confront us are, in fact, much less varied than the problems themselves" (p. 89).

Paige and Simon (1966) investigated problem-solving strategies and classified their subjects as "physical" or "verbal" problem solvers. A verbal problem solver tends to "concentrate on the literal, direct translation of the words of a problem, while a physical problem solver sets up a type of internal representation of the physical situation" (p. 223).

There are some interesting studies by Day (1970, 1973) differentiating cognitive types. In a dichotic listening paradigm, the subject listened to a pair of words, one presented to each ear -- an example being "banket" and "lanket". A perceptual experience reported by many subjects is fusion of the two words -- so in this example, the word "blanket" was perceived. Day found that some subjects fused most pairs while other subjects rarely or

never fused pairs. There was a strong bimodal distribution. As it turned out, the high-fusing subjects were also poor judges of temporal order whereas the low-fusing subjects were good judges of temporal order. In addition to this bimodal performance on the fusion and temporal-order tasks, there were highly correlated differences in other cognitive tasks. Day concluded that in many such tasks, the high-fusers were language-bound subjects, and were constrained by linguistic properties even when they are not necessary for the particular task. The low fusers were not so constrained and could use both a verbal and visual encoding system (Day, 1970). Day classified these subjects as "verbal" and "not verbal".

Many studies divide subjects into high- and low-imagery groups. That is, subjects who use imagery extensively and others who rarely employ imagery. For example, one study showed that because high imagers tend to construct elaborate images expressing the semantic content of a text while reading, they require more time to read imageable material than nonimageable material, and they require more time to do so than low imagers (Denis, 1983). In contrast, people who do not concoct elaborate images show no difference in the time it takes to read imageable or nonimageable material. Paivio (1971) also described many studies showing other differences between high and low imagers.

Physiological Studies Suggesting Cognitive Types

Physiological studies involving brainwave patterns, breathing studies, and lateral eye movements are also suggestive of cognitive types.

Several researchers have related differences in electrical activity of the brain to different modes of thought. This resesarch assumes that there is a relationship between brainwave patterns and thinking. Normally, alpha rhythms are prominent when one's eyes are shut and the mind is (alert but) at rest, and disappear when the eyes are open or with mental effort. Visual imagery, like visual perception, involves activity of the occipital cortex with resultant diminishing of the occipital alpha rhythm. Therefore when a person thinks visually, or thinks in images, the activity on the occipital cortex diminishes, reflecting a different pattern than when a person thinks in auditory or kinesthetic images.

If a person engages in various kinds of thinking, the occipital cortex would reveal a varied distribution of brainwave patterns. However, this is not always the case. Some people have persistent alpha rhythms which are difficult to block even with mental effort (e.g., doing math). Alpha continues even when the eyes are open and the mind is active or alert. These people report that their thinking consists primarily of auditory, kinesthetic or tactile perceptions rather than visual imagery. In contrast, other

people have no significant alpha, even when their eyes are shut and their minds are at rest. These people report that their thinking processes are conducted almost entirely in visual imagery (G. Walter, 1953).

Based on both the EEG characteristics and the verbal reports of 600 people, Walter reported 2/3 of the subject population to be 'mixed', 1/6 to be habitual visualizers, and 1/6 to be habitual verbalizers. Results supporting such distinctions have been obtained in a number of studies (Short, 1953; Slatter, 1960), although others have failed to find evidence of consistent types (Oswald, 1957; Simpson, Paivio, and Rogers, 1967). Although the research is inconclusive, the possibility that a relation may exist between EEG characteristics or EEG profiles and task-specific or habitual modes of symbolic thought deserves continued consideration.

Several studies reported a relationship between regular or irregular breathing patterns and preferred cognitive approach (Chowdhury & Vernon, 1964; Golla & Antonovitch, 1929; Paterson, 1935; Short, 1953; Wikknower, 1934). Briefly, they found that breathing patterns during verbal-auditory imagery were irregular, while the breathing patterns associated with visual imagery were more regular.

Although the exact nature of this irregularity was not identified, it is assumed that "implicit laryngeal movements and possibly implicit movements of the tongue accompany or precede verbal thought processes and thereby distort the regular breathing rhythm" (Richardson, 1977,

p. 122). In other words, while people think verbally, simultaneous mouth movements cause their breathing to be irregular. Hence, habitual patterns can be observed and/or measured.

A suggestion that blood flow reflects different patterns of brain activity was found by Dabbs and Choo (1980). They measured minute differences in the temperature of each cerebral hemisphere. Right handed subjects with high verbal and low spatial abilities had a geater flow on the left, whereas high spatial and low verbal subjects had more flow on the right. In addition, Dabbs (1980) found that while resting, the amount of blood flow to each side of the brain differed for English majors and architecture majors. English majors have a higher level of blood flow in the left hemisphere, and architecture majors in the right hemisphere.

The final physiological measure to be discussed here concerns lateral eye movements. Despite the empirical link discussed earlier between direction of eye movement and the type of question presented to the subject, some investigators (Kinsbourne, 1972; Kocel, Galin & Ornstein, 1974, Galin, Ornstein, & Merrin, 1972) have found strong individual preferences among some of their subjects. Some subjects will consistently turn their eyes (and sometimes their heads) to the right and others will turn to the left. Researchers refer to these subjects as "habitual verbalizers" and "habitual visualizers", respectively.

Interestingly, occupational differences have been related to these lateral eye movements. Bakan (1971) found that left eye movers were more likely to be majoring in the humanities, while science or engineering majors tended to be right-lookers.

Indeed, the above examples all serve to demonstrate that people can be categorized by their thinking style.

Recent Measures

Although there is extensive research emphasizing both the role of visual and verbal processes in cognition, and the tendency of many individuals to rely on one of these types of processes, no measure has been developed that clearly identifies either the styles or the visual and verbal thinkers. Two measures have been developed, however, that approach this goal.

Paivio's I.D.Q.

The first measure is the Individual Differences Questionnaire (IDQ). This 86-item true-false test was developed in the 1970's by Allan Paivio, but it was not published intil 1983. The test includes a broad range of questions designed to measure imaginal and verbal thinking habits, preferences, and abilities. The items, developed by Paivio and his associates, were determined largely on intuitive grounds (Paivio & Harshman, 1983). The basic assumption underlying their work was that "many situations and tasks can be conceptualized either verbally or

nonverbally, and individuals will differ in the extent to which their thinking goes on in one or the other modality" (p. 461, Paivio & Harshman, 1983). It was further assumed that these individual differences would "influence relative preferences for verbal and nonverbal activities, habitual methods of problem solving and remembering, and relative levels of skill for certain verbal and nonverbal activities" (Paivio & Harshman, 1983, p. 462).

The factor analyses (Paivio & Harshman, 1983) tell something more about the measure. A two-factor analysis revealed imagery and verbal scales. A six-factor analysis (which became the primary solution discussed by Paivio) included the following factors: 1) good verbal expression and fluency, 2) habitual use of imagery, 3) concern with correct use of words, 4) self-reported reading difficulties, 5) use of images to solve problems, and 6) vividness of dreams, daydreams, and "imagination."

Paivio's test was an important contribution -- but far from ideal. Unfortunately, there is no factor that concerns habitual use of verbal thought or encoding strategies. In addition, while the verbal factors seem to describe abilities and attitudes, the imaginal factors seem to describe habits.

Hiscock (1978) improved the reliability of the Imagery and Verbal scales of Paivio's test. He also developed a slightly shortened version and incorporated a Likert scale response format. However, he made no other significant changes.

Richardson's V.V.Q.

The second measure, the Visualizer-Verbalizer Questionnaire (VVQ) was developed by Alan Richardson (1977). Using an earlier 150-item version of Paivio's IDQ and a physiological protocol -- the determination of lateral eye movements -- he created a scale by aggregating the questions on the IDQ that differentiated "left gazers" and "right gazers". In other words, if most of the "left gazers" (as defined by their eye movements when responding to a list of questions) answered true to a question that most of the "right gazers" answered false to, it was assumed that this item discriminated between the two types of thinkers. Of interest, when subjects were assigned to visual and verbal groups based on the scores on this test Richardson (1977) found the breathing patterns of verbalizers was be significantly more irregular than those of visualizers.

The items making up this 15-item scale can be seen in Appendix A. Although this measure had high test-retest reliability, it still had some significant shortcomings. First, some of the items were included only because Richardson concluded that they had face validity. Second, different items significantly differentiated left and right gazers in various samples, suggesting low reliability for the measure. Still, the test has a lot of appeal, especially because the 15-item true-false format is so easy to administer and score. Thus, since its creation, the VVQ

has been used in many studies (Akins, Hollingsworth & O'Connell, 1982; Aselander, 1981, 1984; Edwards & Wilkins, 1981; Montgomery & Jones, 1984; Spoltore & Smock, 1983; Warren & Good, 1979).

Rationale and Hypotheses

The present study

The present study is based on the following assumptions.

1. People differ individually in their abilities to solve problems.
2. There are quantitative and qualitative differences in the cognitive processes of individuals which account for these interpersonal variations. These differences vary with age, sex, and other socio-demographic variables.
3. Methods are available which can enhance a person's problem solving behavior.
4. Different methods might be more or less helpful to people with varying cognitive strengths or who rely on various cognitive styles. A method that is helpful for one might be a hindrance to another.

Anderson (1978) claims that a theory that "only specifies internal representations says virtually nothing about behavior and therefore is not testable by itself. One must specify some processes that operate on these internal representations in order for behavior to occur" (p.262). In addition, he says that "one must perform tests of the representation in combination with certain assumptions about the processes that use the representation. That is,

one must test a representation-process pair" (p. 263).

Anderson's notions can be applied to research on cognitive styles. Few psychological investigations have examined cognitive style as a differentiating factor which contributes to understanding other research results or behaviors. For example, research does not address the question of how cognitive styles are related to types of experimental conditions or manipulations. If individuals respond to stimuli differently, certain treatment approaches might prove differentially effective. In other words, individuals' cognitive styles might illuminate some of the variance in other research findings.

These issues were addressed in this study. Not only was attempt made to operationalize visual and verbal cognitive styles, but an assumption about the function of these styles was made and was tested. In particular, this study is based on the premise that verbalization, when used as an intervening process, can help some people solve problems. An individual's cognitive style (that is, whether he or she is more visual or verbal), will predict his or her response to the process of verbalizing.

Development of a measure

Translating the problem-solving behaviors that we see and observations that we make into empirical data is a difficult task. Consequently, researchers have not found an adequate instrument that differentiates visual and verbal thinkers.

The first objective of this study was to develop a measure that could discern visual or verbal thinking styles. To this end, a questionnaire (which is described in detail in the methods section) was developed. To substantiate the value of this instrument, both the reliability and the validity of the newly developed measure were tested. First, however, this instrument was factor-analyzed, with the hope of obtaining "visual thinking" and "verbal thinking" factors.

The reliability was examined two ways. First, the sample was split in half and the factor structures were compared in the two halves to see how similar the factors and the items were. Second, Cronbach's alpha coefficient was computed to determine the internal consistency of the major factors.

The validity of this new instrument was also examined two ways. First, the factors (resulting from the factor analysis of the questionnaire) were examined for face validity. In other words, did visual and verbal factors emerge? For the second test of the validity, experimental and control groups were compared to see if the experimental intervention, which was designed to influence visual and verbal subjects differently, did indeed have this effect. Significant differences would suggest that the measure which categorized individuals tapped into a significant cognitive dimension, hence reflecting additional validity of the instrument.

Major Hypothesis

The major hypothesis of this investigation is that the requirement of overt verbalization as a method of intervention for improving performance on a cognitive task will be differentially effective depending on an individual's visual or verbal cognitive style.

More specifically, if the task is being performed by verbal thinking, and if, as reports suggest, verbal thinking is very much like talking to oneself, one might expect that the requirement of talking aloud should provide a natural mediating function and should aid the thinking process. Indeed there is research indicating this facilitative nature of verbalization (e.g. Craik & Lockhart, 1972; Dusek, 1978; Furth & Milgram, 1973; Fuson, 1979; Gagne & Smith, 1967; Glucksberg & Weisberg, 1966). In contrast, since the visual problem solver most likely constructs some type of visual internal representation of the problem, his problem solving ability may be impaired by instructions to verbalize while solving problems.

Thus, it is predicted that the act of verbalizing will either facilitate or inhibit the process of problem-solving, depending on the compatability of the intervention with the "natural" style of the subject. That is, for those individuals whose thinking is more 'verbal', the process of verbalizing should facilitate problem-solving, whereas for those with a more 'visual' type of thinking, the verbalizing should interfere with their normal approach and therefore hinder their problem-solving ability.

To test the major hypothesis, subjects were randomly assigned to either experimental or control groups. The experimental group was required to use overt verbalization when performing the task at hand, and the control group was not. The differential effect of individuals' cognitive styles (which were measured in several different ways) was tested against the efficacy of the intervention.

Several methods were used to divide subjects into groups having visual or verbal cognitive styles. As was discussed previously, the conceptualization of cognitive style in this investigation refers to the relative dominance of one type of thinking over another. Therefore, cognitive style was operationally defined by using several 'difference scores'. (Similar difference scores for determining cognitive styles were used by Dabbs and Choo, 1980), The first cognitive style measure consisted of the difference (in standardized scores) between subjects' scores on a "visual thinking" factor and a "verbal thinking" factor.

Because of the expected relationship between cognitive styles and abilities, one would expect a person with a verbal cognitive style to have stronger aptitudes in verbal abilities than visuospatial abilities. Therefore, the second measure was created by using the difference between a verbal abilities test and a visuospatial test.

Secondary Hypotheses

Only minor group differences are predicted in cognitive abilities, styles, and responses to items.

Sex differences. Sex differences in spatial dimensions and verbal abilities have been demonstrated in older as well as younger persons. When there are differences, males are usually found doing better on spatial tests and females usually excel on verbal tasks (Baltes & Schaie, 1976; Blum, Fosshage & Jarvik, 1972; Broverman, Klaiber, Lobayashi & Vogel, 1968; Buffery & Gray, 1972; Nesselroade, Schaie & Baltes, 1972; Schaie & Strother, 1968; Maccoby & Jacklin, 1974). The interpretation of these data is not without controversy, however, and there are often no reported sex differences.

In this investigation, only minor sex differences are predicted. Sex differences are expected on some items from the questionnaire. When the sexes differ, males will agree more with the visual or spatial items, and females will agree more with the verbal items. No other sex differences are predicted.

Age Differences. Several age differences are hypothesized. Age-related cognitive research has demonstrated that younger and older subjects differ in the types of mediators they use. Specifically, young persons show a strong preference for imagery, while the elderly tend to use more verbal mediators (Gordon & Slevin, 1975; Hulicka and Grossman, 1967; Hulicka, Sterns, & Grossman, 1967; Reese, 1962, 1970; Rowe & Schnore, 1971). Berg, Hertzog and Hunt (1982) concluded that only half of their subjects

over 40 could adopt an imaging strategy in the sentence-verification paradigm. There is also much research suggesting that aging individuals maintain verbal intelligence well into old age, whereas, in contrast, there is a gradual decline in nonverbal intelligence starting at a much younger age (Horn, 1976a, 1976b; Horn & Cattell, 1967; Forisha, 1975; Wilkie & Eisdorfer, 1974). Thus, it is hypothesized that old people will be more verbal than young people. It is predicted that this will be reflected in different responses to some items from the questionnaire and on cognitive style measures.

An age-scale was created to assess subjects confidence in their thinking, and a sense of changing cognitive abilities as they age. It is hypothesized that the older subjects will respond differently than the younger subjects on this scale. It is also predicted that different factors that emerge on the factor analyses for the old and young will reflect the importance of different cognitive dimensions for the two age groups. No other are differences are predicted.

It should be noted that old and young subjects were not matched for educational background, ethnicity or religious background. In addition, sampling procedures were different for the two groups. Consequently, while the above mentioned age differences will be examined, attributing any significance to age per se, cannot be conclusive.

Chapter II

METHODS

The task of operationalizing such elusive concepts as verbal and visual cognitive styles was a complex and sometimes frustrating process, as was the development of an appropriate methodology to study these concepts. This chapter begins with a description of the pilot study and the research goals which led to the development of the measures and methods, as well as a change in the major sample involved in the study. The pilot study highlighted methodological issues and difficulties involved in doing this kind of research on the elderly. Consequently, the design, which was originally intended to focus on cognitive styles and changes in the elderly, was changed to focus on a younger sample.

In the remainder of this chapter, specific methodological issues and the methods used in the present study are discussed. This includes the sample and sampling procedures, the measures, and the specific procedures involved.

Pilot Study

Subjects

The 12 subjects in the pilot study were all elderly subjects from a retirement community in San Francisco. The eleven women and one man were all relatively healthy and

middle class. One woman was black, the rest of the sample was white. The average age was 78.6.

Subjects' names were provided by the director of activities as individuals who were interested in participating. Appointments were set up by phone and individuals were met in their apartments.

Measures and Experimental Design

The primary purpose was to investigate whether the act of verbalizing on a reasoning test helped verbal individuals more than it helped visual individuals. Half of the subjects (randomly selected) were required to overtly verbalize, and the other half were not instructed to verbalize. After all the data was collected, and after dividing subjects into visual and verbal groups (based on their performances and responses to specific measures), these two groups were compared.

Several measures were involved in this study. Richardson's Visualizer-Verbalizer Questionnaire (VVQ), a 15-item true-false test, was used as the primary method of determining cognitive style. Two WAIS (Wechsler Adult Intelligence Scale) subtests were used to permit comparisons of visual and verbal abilities with cognitive styles. The Raven's Progressive Matrices test (hereafter called Ravens) was used as the inductive reasoning test which half the subjects talked their way through.

For the WAIS subtests the Information Test and the Picture Completion Test were used. However, several

problems with the use of these subtests for this sample rendered many of the results inconclusive. First, because general information is requested for the information test, there was a disadvantage for those not educated in this country and for those subjects who didn't finish school because of economic and other conditions. Many of these (elderly) subjects suffered these disadvantages.

Second, when asked what was missing from the picture completion items, the subjects sometimes pointed out things that younger people would never consider -- things that used to be important but have been replaced by more modern conveniences. An example is a running board as a missing item on a car. According to Wechsler's Manual (1955), these answers are considered to be incorrect. After subjects pointed out an important missing item, it was hard to get them to choose another important missing item -- because in their minds, the first item was an adequate (or correct) answer.

A third factor affecting testing was that many of these subjects did not particularly care whether they got the right answer. Although this can be a problem at any age, it seemed more profound for these elderly subjects. Comments such as "I'll choose this answer, I know it's not right but I like to do things my own way," or "I'll pick this one, it's prettier than the rest," or "I'll pick this, because I like yellow," make evaluating the results especially difficult. Surprisingly, very little is

reported in the cognitive literature describing such attitudes or responses in reports of other cognitive resesarch on the elderly.

Of interest, even with the difficulties described, and even with the small number of subjects (N=12), there were some significant results. For those who talked their way through the Ravens Matrices, there was a direct relationship between their performance and their scores on Richardson's VVQ. Specifically, "verbal" subjects' did better when they talked, and "visual" subjects did worse when they talked. There were no significant differences for the control group, and no significant differences using the WAIS subtests.

Despite the fact that significant differences were obtained between visual and verbal subjects (as defined by their scores on Richardson's VVQ), the practical and methodological problems with other tests contributed to the decision to re-evaluate the methodology and focus primarily on a younger sample. Perhaps the best time to work with an older population is after research with younger age groups has established strong empirical bases for expectations. Otherwise, distinguishing psychological issues from methodological issues might be impossible.

The remainder of this chapter concerns methodological decisions and a description of the methods for the present investigation.

Subjects

Two age groups were involved in the present investigation: a college-age group and a group composed of subjects over 60 years old. Both men and women were included.

College Student Sample

The questionnaire was administered to 361 subjects, 154 males and 207 females. These subjects filled out the questionnaire in introductory psychology classes at San Francisco State University. Nine classes were involved. Although the professors had given up class time to allow student participation, it was communicated to the students that it was completely their choice to become involved. The students were told briefly about the general nature of the study and the option of attending the second, individual meeting. The students were told that the study concerned different thinking styles, that their intelligence was not being tested, and that the details of the study would be explained in full at the end of the second session. They were told that even if they didn't participate in the second part, filling out the questionnaire would be very helpful and appreciated. Approximately 98% of the students in all 9 classes filled out the questionnaire.

On the questionnaire, students were asked whether they were interested in further participation. Those interested

were contacted by phone and individual appointments were set up. Of the 181 students that did volunteer, only 125 actually participated in the experimental portion of the study. Some of the students failed to put their phone numbers on the questionnaire, so they could not be contacted. Some subjects wanted to participate but had new jobs and no longer had the time. Others had been unavailable or unable to coordinate schedules with the experimenter.

Some subjects were called but were disqualified from participating because English was not their primary language. The orientation toward another language could affect scores on the WAIS Vocablulary Test and have an effect on the experimental (verbalizing) condition on Ravens. Subjects whose English was very poor (as noted by their comments on the questionnaire) were not called.

Of the 361 college students who filled out the questionnaire, 45% were Catholic, 20% were Protestant, 8% were Jewish, 5% were Fundamentalist, 3% were Moslem, 2% were Buddist, and 17% were unreported. The ethnicity also varied tremendously. Fifty five percent were White European, 24% were Asian, 8% were Hispanic, 5% were Black, 5% were Mid-eastern, 1% was American (self-described), and 2% were unreported.

The age range was from 17 to 26, and the average age was 20. Of the 125 who did participate in the experimental portion of the study, 56 were male and 69 were female. All

students who participated in the experimental portion of this study took 3 different cognitive tests.

Older Sample

The older participants were recruited from retirement communities, the San Francisco Jewish Community Center, and the Fromm Institute at the University of San Francisco. In the Jewish Community Center and some retirement communities, individuals were approached individually or in small groups, and asked to fill out a questionnaire for dissertation research. They were told that it would take them approximately 20 to 30 minutes, and that it contained questions about thinking styles. If they inquired further about the purpose of the test, they were told that it had nothing to do with testing intelligence, cognitive impairment, or senility. This had been a concern of some older subjects in the pilot research.

In one site, initial contacts were not made on a face-to-face basis. The activities director of one of the retirement communities provided a list of individuals who said they would be willing to participate. Appointments were made by phone, and subjects were instructed to pick up the questionnaire at the office. The experimental portion was administered at the individuals' apartments.

The last group of older subjects was obtained from the Fromm Institute. The Fromm Institute is a multifaceted continuing education program for individuals over 60. A

short cover letter and a complete copy of the questionnaire used for this dissertation were published in the Institute's monthly bulletin. Interested individuals turned in completed forms, and those who were interested in participating further were contacted by phone. The experimental portion was administered at the arranged time and place -- either in the subject's residence or in an interview room in University Center at USF.

Seventy seven older subjects filled out the questionnaire. Forty four percent of these were Jewish, 26% were Catholic, and 25% were Protestant, and 5% were unreported. Eighty nine percent were White European, 5% were Black, 5% were Asian, and 1% was Hispanic.

The ages ranged from 60 to 89, and the average age was 71.1. Of the 77 older adults who filled out the questionnaire, 60 volunteered to participate in the experimental portion. Of the 42 who actually did participate in the experimental portion, 34 were female and 8 were male. Thirty-two older subjects were from the Fromm Institute, 6 were from retirement communitites and 4 were from the Jewish Community Center.

Measurement Instruments

There were four primary measures involved in this investigation. One instrument was created by the experimenter and three were standardized tests.

1. Cognitive Questionnaire

Test Construction

No adequate measurement instrument was available to differentiate individuals with visual and verbal cognitive styles. This issue was discussed with a recognized expert in the field, Dr. Allan Paivio. Paivio said the test that most closely filled the needs of this research was his own Individual Differences Questionnaire (IDQ), and that he would send a copy of this soon-to-be-published test (Personal Communication, April, 1983). The test was published in 1983 (see Paivio and Harshman, 1983).

Paivio's questionnaire contained self-report items concerning visual and verbal preferences, aptitudes, attitudes and habits. His research included a factor-analysis of this measure from which several cognitive factors were derived. However, some very important dimensions remained untapped by his questionnaire -- particularly, factors reflecting verbal thinking, or thinking in words. Paivio was aware that these dimensions were not adequately represented in his test, and suggested using one's intuition to generate questions that adequately tap these areas (Personal communication, May, 1983).

Therefore, many new items were created by this investigator. They come from several sources. Some of the items are indirect results of related research and theoretical work in the area. Some of the most influential sources include: 1) Fodor (1974, 1981), 2) Kaufman (1980),

3) Weisberg (1980), 4) Edwards (1979), 5) Springer and Deutch (1981), 6) Pick and Salzman (1978), and 7) Sokolov, (1972). Other items were based on the investigator's experience, observations, and discussions with people. Many revisions were involved before the final version of this questionnaire was made acceptable.

When the new questionnaire was first created it contained 64 new questions and Paivio's entire 86-item test. However, feedback from individuals who pre-tested the instrument said the test was much too long. Twenty five items were therefore dropped. These include questions from Paivio's IDQ that had less than a .25 loading on any of the factors in Paivio's factor analysis, as well as many of the newly created questions.

The questionnaire was again pretested, and still there was strong feedback that the now 125-item test was too long. So, based on more discussions with people and reactions from those pretested, the questionnaire was finally reduced to 64 cognitive items. Some items, such as the 15 from Paivio's IDQ that made up Richardson's VVQ, were kept so that important comparisons could be made. The final version contained 23 from Paivio's IDQ, and 41 other cognitive items created specifically for this study. It should be noted that there were still many reactions from subjects, especially younger subjects, that the test was too long and too repetitive.

Age-related Questions

There were initially 10 age-related items included in the questionnaire with the cognitive items, but this was reduced to 4 in the final cut. The items included were: 1) "I do not remember things as well as I used to." 2) "As I get older, my mind seems to function better than ever." 3) "My reasoning ability seems to get better as I get older." 4) "I now have difficulty figuring things out which used to be easy for me." These items, which were combined to make up an `agescale', were intended to determine whether people felt their cognitive style or thinking processes had changed much over the years, or whether they had less confidence in their thinking than they used to have. Although the same items were given to all subjects, they were primarily aimed at the older sample.

If responses to the items suggested that subjects did not remember or reason as well as they used to, and if these subjects had a different style than those who were not aware of such declines, then interpretations of the findings should consider the possibility that either the changes in cognition or the changes in subjects' confidence in their cognitive processes may be responsible for the results.

These `agescale' items were included with the cognitive items to couch the items so the older subjects did not feel that their intelligence was being tested, or that senility or declining mental abilities was being

implied. The pilot study had indicated that these were fairly common apprehensions among some older subjects.

Test Format

After the additional items were constructed, they were placed in random order. The questionnaire was then examined to make sure there were no strings of similar items together. Although space didn't allow for positive and negative forms of the same items, the questionnaire was constructed so that there were equal numbers of positive and negative visual and verbal items.

Hiscock (1978) used the Likert scale format in his revision of Paivio's test. In his attempt to improve Paivio's I.D.Q, Hiscock had five available responses per item, instead of two. He obtained slightly higher reliability. Therefore, this format was used for the questionnaire in this investigation. Paivio and Harshman (1983) agreed that the sensitivity of the test may be improved by going to a Likert scale format.

Description of the Cognitive Measure

The primary measurement instrument used in this study was a Likert-format, true-false questionnaire, composed of 68 items. It contains 4 age-related questions and 64 questions concerning cognitive habits, skills, preferences, styles, etc. The primary purpose of this questionnaire was to provide cognitive items that could be factor analyzed,

with the expectation of deriving factors related to visuo-spatial and verbal modes of thinking. This expectation is based partially on Paivio's factor analysis of his measure (1983) and partially on the assumptions underlying the creation of the new items.

The complete list of items on the questionnaire can be seen in Appendix A. In the appendix, items are identified as coming from the Paivio and Richardson scales, as the age-related items, or as the newly created cognitive questions. The same questionnaire was given to subjects of all ages.

In addition to this new cognitive instrument, a separate sheet containing a few questions regarding personal or demographic variables was included with the consent form and the instructions and stapled to the questionnaire. Thus, the final questionnaire consisted of the consent form, the instructions, demographic questions, the age-related items, and the cognitive items. It took the subjects approximately 20-25 minutes to fill out the questionnaire. A copy of the entire questionnaire is in Appendix B.

2. Block Design

This instrument is one of the subtests of the Wechsler Adult Intelligence Scale (WAIS). It was used as the measure of spatial ability for several reasons. First, it has good face validity as a measure for this dimension. Second, for the college-age group involved, it correlates

most highly with the Performance Scale of the WAIS (r=.71, Wechsler, 1955). Although the Performance Scale is not "visual" per se, it is the test of more fluid abilities and contains mostly visual and spatial tasks. This test has been used by others as a general test of visuo-spatial abilities (McGlone & Davidson, 1973; Kinsbourne, 1978). Finally, the Block Design can be compared to the Vocabulary Test more directly since normative and comparative data are available from both.

The Block Design involves subjects' manual manipulation of first four, then nine blocks to reproduce 10 increasingly difficult two-dimensional designs. Forty-eight is the maximum score obtainable on this measure (Wechsler, 1955). This test takes approximately 10 minutes to administer.

3. Vocabulary Test

This instrument, another of the subtests of the WAIS, was used as a measure of verbal ability. Although vocabulary is not necessarily directly indicative of verbal ability, for this age group, it correlates most highly with the Verbal Scale of the WAIS (r=.84, Wechsler, 1955). It was therefore considered the best indicator available.

This test involves subjects' definitions of 40 increasingly difficult words. The maximum number of points obtainable is 80 (Wechsler, 1955). This test takes approximately 10 minutes.

Of interest, the Block Design and Vocabulary tests were used by Roberts (1971) as tests of general verbal and nonverbal cognitive abilities.

4. Raven's Standard Progressive Matrices

The final measure was the age-appropriate version of Raven's Progressive Matrices (hereafter called Ravens). The instrument is a non-verbal inductive reasoning test that can be solved with either "visual" or "verbal" strategies. Subjects are shown a pattern with a piece removed and instructed to choose from an array of eight, the part that completes the more complex pattern presented. Four examples of the problems are in Appendix C. There are 12 progressively harder designs in each set.

Raven (1938, 1960) described the test as a "test of a person's present capacity to form comparisons, reason by analogy, and develop a logical method of thinking regardless of previously acquired information" (p.12). Hunt reported that there were commonly two general approaches to solving Ravens Matrices: "a Gestalt algorithm which is based on the manipulation of visual images, and an analytic algorithm, which is based on formal operations applied to sets and subsets of element features" (1982, p. 182). These two strategies can be viewed as visual and verbal approaches.

The college students used Raven's Standard Progressive Matrices, and the older subjects used Raven's Colored Progressive Matrices. These are the versions deemed

appropriate for the particular age groups involved (Raven, 1960). For the college students, only sets D and E, intended as the most difficult, were used (Raven, 1958). Accordingly, the maximum score obtainable was 24. For the older subjects, sets A, Ab and B were used. The maximum score obtainable for them was 36.

Procedure

Experimental Procedure for College Subjects.

As described, the college students filled out the cognitive questionnaire in classes. From those who volunteered to participate further, a subsample was recruited for the experimental portion of the study. The subjects in the experimental groups met with the experimenter in an office in the Psychology Building of San Francisco State University, and took the 3 cognitive tests (two WAIS subtests and Ravens).

First, subjects took the Block Design Test. They were given a modified version of Wechsler's instructions. First, 4 blocks were taken out of the box. Each subject was told:

> See these blocks? They are all exactly the same. They all have 2 white sides (pause to show them), 2 red sides (shown again), and 2 sides which are half red and half white - cut diagonally. Now what I want you to do is take these blocks and make the picture I show you with the blocks. For each one, tell me when you are finished - when the blocks are exactly the same as the picture. Okay?

The subjects times were recorded discreetly by the experimenter, so that the subjects did not feel pressured. After the first 6 designs were completed, the experimenter took out the remaining 5 blocks and said:

> For these last 4 pictures, you will use all 9 blocks. These blocks are exactly the same as the others you were working with. Again, tell me when you are finished with each one.

The times for the remaining 4 items were recorded and later scored in accordance with Wechsler's instructions. Four points are given for each right response within the time limits allowed, and up to 2 points are available as bonuses for getting any of the last 4 items in shorter periods.

Next, subjects took Ravens Progressive Matrices. They had already been randomly assigned to either the experimental or control condition. The control groups (one for each age) were given the age-appropriate set of Progressive Matrices with the standard instructions. The experimental groups were also given the appropriate sets of matrices. However the subjects were given the additional instructions to "talk out loud" as much as possible while they were solving the problems. It was communicated to them that their speech would not be evaluated, and they they should not feel any pressure in this regard. They were told that their talking should be for them, to guide them or help them, and that the purpose of the talking was not to explain what they were doing to the experimenter.

It should be noted that subjects were randomly assigned into either the verbalizing or the control group without the prior evaluation of their cognitive `style'. The purpose of this is to keep the experimenter blind to the desired or expected reaction of the subject to the treatment. Another consequence of this however, is that the cells will have unequal numbers.

Non-verbalizing (control) condition. Subjects in the non-verbalizing condition were instructed in accordance with Raven's manual:

> Look at this (the experimenter pointed to the upper figure). It is a pattern with a bit taken out. Each of these bits below (the experimenter pointed to each in turn) is the right shape to fit the space but they do not all complete the pattern. Tell me the number of the piece which is right. On every page there is a pattern with part left out. All you have to do is tell me each time the bit which is the right one to complete the pattern. They are simple at the beginning and get harder as you go on. But if you pay attention to the way the easy ones go, you will find the later ones less difficult. Now carry on at your own pace. See how many you can get right. There is no need to hurry. These are not timed at all. So be careful. Remember, each time only one part is exactly right.

Verbalizing (experimental) condition. Subjects in the verbalizing condition were given additional instructions (as indicated by the underlinings):

> Look at this (the experimenter pointed to the upper figure). It is a pattern with a bit taken out. Each of these bits below (the experimenter pointed to each in turn) is the right shape to fit the space but they do not all complete the pattern. On every page there is a pattern with one part left out. All you have to do is tell me each time the bit which is the right one to complete the pattern.

As you do each problem, I want you to think out loud as much as possible. Try to use language and talk your way from the beginning to the end of each problem, sort of talking yourself through the problem, and then tell me the number of the right piece. I'm not measuring or evaluating your speech in any way. I just want you to try to use your speech to guide yourself through the problem to find the right piece to complete the pattern. Your speech is only for you, not for me. Please don't feel you have to explain what you are doing or explain your reasoning to me. Okay? Now, these problems are simple at the beginning and get harder as you go on. But if you pay attention to the way the easy ones go, you will find the later ones less difficult. Now carry on at your own pace. See how many you can get right. You can have as much time as you like. There is no need to hurry. These are not timed at all. So be careful. Remember, each time only one part is exactly right. Also, if you stop talking for a while, I'll remind you to talk. (If this occurred, the experimenter said softly, "you're not talking," or "I don't hear anything," or just "talk.")

The experimenter wrote down the verbalizations as unobtrusively as possible. In addition, with permission from subjects, verbalizations of all subjects were recorded on a cassette recorder. From these 2 records, fairly complete transcriptions were made for each subject. The purpose of these transcriptions was to allow examination and comparisons of the speech of the subjects, both in terms of quantity of words and the types of utterances spoken. No subjects refused to have his or her verbalizations recorded.

Finally, subjects took the Vocabulary test. The subjects were given a modified version of Wechsler's instructions. The vocabulary list was placed in front of each subject, and the subject was told:

> This last part of the study is a word list. Basically, I just want to know whether or not you know what the word means. I do not need an elaborate definition, and your definitions are not being evaluated in any way. So I'll go through the list - and you can see each word in front of you there - and you tell me what each word means. If you don't give me enough of a definition, I'll ask for more or ask you to explain more fully. So, don't worry about your definition. Okay?

The subject then attempted to define all 40 words, beginning with BED. If the subject's definition had any element of correctness, the subject was asked for more information. However, if a completely wrong answer was given (i.e. `old fashioned' for the word `calamity', or `to slander' for the word `plagiarize'), no follow up was asked for and the subject received no points for that answer. The definitions were later scored in accordance with Wechsler's instructions.

After the testing, the nature of the study was explained to each student and discussed to whatever extent the student desired. When possible, the students reactions and comments were noted. Although every student was told that he or she could stop at any point or not take further tests, only one student chose not to participate fully in all the testing.

Ordering of the tests. Although it was originally planned to vary the order of the tests, it was decided that this was not the most logical approach. First, it was desirable for each subject to take all 3 cognitive tests, and it was important that the subject did not get too

fatigued or lose motivation. Since the Vocabulary test depends more on knowledge and less on cognitive manipulation or aggressive strategies than the other tests, it was judged to be probably the least affected by fatigue or lack of motivation. Thus, having it last was the most logical. Second, once a subject was told to verbalize while doing a test, there was no way to control the effect of these instructions on subsequent testing. Therefore, it was decided that Ravens had to be administered after the Block Design for the subjects in the Verbalizing Condition. If subjects in the control group were not treated similarly, then differences between the experimental and control groups might be attributable to the ordering of the tests. So, putting the tests in the described order seemed the most logical approach.

Experimental Procedure for Older Subjects.

Because of the difficulties in the pilot study, WAIS subtests were not administered to elderly subjects. At the meetings at the arranged times and places, only Ravens was administered. The procedure for Ravens was the same as for the college students. The same instructions were used for the Verbalizing and the Control conditions.

Because the pilot study had indicated some apprehension on the part of many elderly subjects regarding the 'real' purpose of this test (e.g. to test them for senility) it was decided that recording subjects

verbalizations -- either by hand or by machine, could be intimidating, and so this procedure was omitted.

After Ravens, the nature of the study was again explained and discussed to the extent to which each subject was interested.

Chapter III

RESULTS

One of the primary goals of this investigation was to discern visual and verbal thinking styles. The other main goal was to investigate whether individuals who have one of these two styles as a predominant mode of thinking are differentially affected by the act of verbalizing in a problem-solving situation. Both older and younger samples were involved.

Visual and verbal factors were derived from a factor analysis of the cognitive items on the newly developed questionnaire. These factors were used as one of the primary means of dividing subjects into visual and verbal groups. The other primary method for categorizing subjects involved two abilities tests: the Block Design and Vocabulary Test. Raven's Progressive Matrices was the inductive reasoning test which half the subjects talked their way through.

Before the results are described, some summary statistics concerning the subjects and the data involved in this study will be presented. Then, before I begin with the first hypothesis, I will describe the results of the factor analyses, for both the younger and the older sample. The first hypothesis will then be presented in detail. I will then present results that concern the testing of the

validity and reliability of the measure created for this study. This will be followed by the results for the secondary hypotheses, which concern sex and age differences.

Summary Statistics

The mean scores on the Vocabulary Test, the Block Design and Ravens, for both the verbalizing and non-verbalizing conditions are presented in Table 1, for the males and females in the younger sample.

TABLE 1

Mean Scores on Vocabulary, Block Design, and Ravens, for Younger Males and Females

	Total Sample	Males (N=56)	Females (N=69)
Block Design	40.83 SD=5.94	41.34 SD=5.60	40.42 SD=6.21
Vocabulary	62.21 SD=10.29	63.32 SD=10.49	61.30 SD=10.11
Verbalizing (Ravens)	17.93 SD=3.64	18.00 (N=25) SD=4.01	17.88 (N=43) SD=2.99
Non-verbalizing (Ravens)	18.60 SD=2.77	18.81 (N=31) SD=3.32	18.35 (N=26) SD=2.37

Of the 125 students that participated in the experimental portion, there were 56 males and 69 females. Sixty-eight subjects verbalized while solving Ravens (25

males and 43 females), and 57 subjects did not verbalize (31 males and 26 females).

The mean scores for the older sample on Ravens, for both the verbalizing and non-verbalizing conditions are presented in Table 2.

TABLE 2

Mean Scores on Ravens for Verbalizing and Non-verbalizing Older Males and Females

	Total Sample	Males (N=8)	Females (N=34)
Ravens			
Verbalizing	30.41	22.0 (N=2)	31.25 (N=20)
Non-verbalizing	29.10	28.0 (N=6)	29.57 (N=14)

Of the 42 older subjects that participated in the experimental portion, there were 8 males and 34 females. Two males and 20 females were in the verbalizing condition, and 6 males and 14 females were in the non-verbalizing condition.

Factor Analysis

It was considered that the factors derived from the factor analysis of the questionnaire might be different for the two age groups, and also that these differences could interfere with the possibility of obtaining clean factors. To test this, these samples were factor analyzed both together and separately. The factors were computer generated.

When the old and young samples were factor analyzed

separately, the first two factors of each represented a strong "verbal thinking" factor and a "visual thinking" factor. The items on these factors were somewhat different however, and when the two samples were factor analyzed together, the items making up the visual and verbal factors were dispersed among several factors. In addition, the two strongest factors were both verbal. This led to the conclusions that there were important differences between the two age groups and that the samples should not be combined for this analysis. Only the separate factor analyses will be described.

Primary Factor Analysis - Younger Sample

The intercorrelation matrix of the 64 cognitive items from the questionnaire was factor analyzed using a principal component analysis with the diagonals given a value of 1.00. Factors with eigenvalues greater than one were included in further analyses. On this basis, nineteen factors were extracted and subjected to a varimax rotation. The nineteen factors accounted for 62.3% of the total communality. Of the nineteen factors, only eight had sufficient item loadings to be interpretable. These eight factors accounted for 40.7% of the total communality. The factors were named based on the similarities of content of the items with factor loadings that exceeded .30 on that particular factor. A complete list of the factors, the percentages of communality accounted for by each, and the items loading .30 or more, can be seen in Table 3.

TABLE 3

Factor Analysis for the Young Sample: Eight Factor solution, the % of communality accounted for by each factor, and Items with Loadings > .30

Item # and Description		Factor Loading
	FACTOR 1: VERBAL THINKING (11.4%)	
68.	My thinking is more "verbal" than "visual."	.835
67.	My thinking is more "visual" than "verbal."	-.820
59.	When thinking, I use language and words much more than I use visual images.	.764
61.	Thoughts are represented in my head in the form of words.	.736
58.	Words are needed for conversation with others. Privately, I do not need to rely on words for thinking.	-.590
60.	I have a strong nonverbal sense of things.	-.496
4.	Most of my thoughts are verbal in nature.	.479
45.	My thinking often consists of mental pictures or images.	-.377
55.	When I am alone with my thoughts, I find that I usually have visual images of what I am thinking about.	-.348
20.	When thinking or talking to myself, I find that don't use words for ideas and objects that I can visualize	-.329
24.	Images of people and things do not just pop up in my head. They are filled in from verbal or written descriptions.	.313
	FACTOR 2: VISUAL THINKING (9.4%)	
16.	I often use mental images or pictures to help me remember things.	.700

45.	My thinking often consists of mental pictures or images.	.699
10.	I often use mental pictures to solve problems.	.667
42.	By using mental pictures of the elements of a problem, I am often able to arrive at a solution.	.672
18.	Thoughts are often represented in my head in the form of images and pictures.	.618
55.	When I am alone with my thoughts, I find that I usually have visual images of what I am thinking.	.484
1.	When I talk to someone on the phone, I often have a visual image of the person I am talking to.	.461
34.	I get visual images while I read, even of complex or abstract ideas.	.415
51.	I can easily picture moving objects in my mind.	.374
54.	I do not form a mental picture of people or places when reading of them.	-.328

FACTOR 3: TROUBLE WITH WORDS (4.7%)

38.	My thoughts and ideas tend to be so intertwined that I often don't know what order to present the ideas in when I speak.	.710
23.	When I talk, I tend to go off on tangents.	.590
57.	I am able to express my thoughts clearly.	-.573
50.	When I talk or write, it is hard for me to find words that express the connection between ideas.	.562
65.	My thoughts are easily translated into words.	-.530
21.	I sometimes have ideas that I have trouble expressing in words.	.504
36.	Even when someone is talking about something I am interested in, I find myself easily distracted.	.351
56.	When I talk or write, it is hard for me to find words that express the connections between ideas.	-.322

FACTOR 4: GOOD WITH WORDS (3.9%)

44.	I enjoy learning new words.	.762
25.	I spend very little time attempting to increase my vocabulary.	-.682
19.	I enjoy doing work that requires the use of words.	.590
22.	I consider myself to be a "word" or "verbal" person.	.435
29.	I have better than average fluency in using words.	.389
39.	I read a great deal.	.358
57.	I am able to express my thoughts clearly.	.355
37.	I seem to be very aware of detail in my surroundings.	.351
43.	I can easily express myself in writing.	.321

FACTOR 5: CAN DO TWO THINGS AT ONCE (3.2%)

63.	It is difficult for me to do more than one thing at a time.	-.727
41.	I find it easy to do other things while I watch television.	.706
3.	I cannot listen to two things at the same time.	-.604
49.	I can "turn off" noise or chatter in my environment so it does not bother or distract me.	.569

FACTOR 6: STRONG DREAMS (3%)

32.	My dreams are extremely vivid.	.667
15.	My daydreams are rather indistinct and hazy.	-.588
40.	My day dreams are sometimes so vivid I feel as though I actually experience the scene.	.576
27.	I seldom dream.	-.558

54.	I do not form a mental picture of people or places when reading of them.	-.386
55.	When I am alone with my thoughts, I find that I usually have visual images of what I am thinking about.	.377
34.	I get visual images while I read, even of complex or abstract ideas.	.311
1.	When I talk to someone on the phone, I often have a visual image of the person I am talking to.	.305

FACTOR 7: GOOD WRITTEN EXPRESSION (2.7%)

46.	I can express myself more clearly when I write than I can when I talk.	.873
52.	I can express myself more easily when I talk than I can when I write.	-.873
43.	I can easily express myself in writing.	.598
39.	I read a great deal.	.346

FACTOR 8: READING DIFFICULTIES (2.5%)

30.	When I read, I sometimes have to read passages over several times to understand what I am reading.	.685
64.	I read rather slowly.	.610
39.	I read a great deal.	-.521
56.	I can usually explain how I got from the beginning of a problem to the final solution or conclusion.	.374
25.	I spend very little time attempting to increase my vocabulary.	.309
36.	Even when someone is talking about something I am interested in, I find myself easily distracted.	.301

The first factor that emerged included items related to one's thoughts being verbal, not using images in thinking, and relying on words when they are not necessary. The major content and theme related to this factor was "verbal thinking". The second factor that emerged was "visual thinking" and included items related to thinking in images, using pictures for remembering things and solving problems, and tending to form images of friends and reading material. The third factor, "trouble with words" included items related to having difficulty expressing oneself, easily going off on tangents or being distracted, and having one's thoughts intertwined or not easily translated into words. The fourth factor, "good with words", included items related to feeling like a word person, feeling fluent, and enjoying working with and learning words. The fifth factor, "doing two things at once" contained items related to being able to do two things at the same time, listen to two things at the same time, or concentrate on one thing without being bothered by another ongoing event. The sixth factor, "strong dreams", included items related to having many dreams, vivid daydreams, or forming images in situations. The seventh factor, "good written expression", concerned items related to being able to express oneself easily in writing (as distinguished from talking). The eighth and final factor, "reading difficulties", contained items related to reading slowly, needing to reread passages, or not reading much.

Factor Analysis for Older Sample

The factor structure for the older sample was statistically determined in the same manner as the younger sample. As with the younger sample, there were nineteen factors, of which eight were interpretable. These eight factors accounted for 51.6% of the communality (as compared to approximately 41% accounted for by the first eight factors for the younger sample). The first factor that emerged was a strong verbal factor, "clear verbal expression and verbal thinking". It differed somewhat from the younger sample's "verbal thinking" factor. Using the items with factor loadings over .30, this factor included all but two of the items that were in the young sample's factor. However, there were additional items concerning good verbal expression and having greater or lesser facility with words. These items had very strong loadings on this factor. For the younger sample, constructs such as being good with words, having difficulty with expression, or having trouble with words, comprised separate factors. For a list of the factors with all items loading over .30 the reader is referred to Table 4.

The second factor that emerged was "visual thinking". The major themes included thinking in images, using mental pictures to remember things and to solve problems, and habitually using imagery in situations. The third factor was "word person". This included items related to thinking verbally, enjoying words and generally identifying oneself

TABLE 4

Factor analysis for the Old Sample: Eight Factor Solution, the % of communality accounted for by each, and Items with loadings > .30

Item # and Description	Factor Loading
FACTOR 1: CLEAR VERBAL EXPRESSION AND VERBAL THINKING (13%)	
57. I am able to express my thoughts clearly.	.818
50. When I talk or write, it is hard for me to find words that express the connection between ideas.	-.778
29. I have better than average fluency in using words	.718
56. I can usually explain how I got from the beginning of a problem to the final solution or conclusion.	.708
21. I sometimes have ideas that I have trouble expressing in words.	-.650
53. I can easily think of synonyms for words.	.535
38. My thoughts and ideas tend to be so intertwined that I often don't know what order to present ideas in when I speak.	-.527
43. I can easily express myself in writing.	.448
14. Most of my thoughts are verbal in nature.	.436
61. Thoughts are represented in my head in the form of words.	.417
68. My thinking is more "verbal" than "visual".	.395
67. My thinking is more "visual" than "verbal".	-.357
30. When I read, I sometimes have to read passages over several times to understand what I am reading.	-.354
59. When thinking, I use language and words much more than I use visual images.	.347

36.	Even when someone is talking about something I am interested in, I find myself easily distracted.	-.335
34.	I get visual images while I read, even of complex or abstract ideas.	.320
8.	I would find it difficult to write an outline before	.305

FACTOR 2: VISUAL THINKING (10.4%)

18.	Thoughts are often represented in my head in in the form of images and pictures.	.799
45.	My thinking often consists of mental pictures or images.	.788
55.	When I am alone with my thoughts, I find that I usually have visual images of what I am thinking about.	.766
42.	By using mental pictures of the elements of a problem, I am often able to arrive at a solution.	.661
34.	I get visual images while I read, even of complex or abstract ideas.	.544
59.	When thinking, I use language and words much more than I use visual images.	-.496
1.	When I talk to someone on the phone, I often have a visual image of the person I am talking to.	.492
10.	I often use mental pictures to solve problems.	.478
68.	My thinking is more "verbal" than "visual".	-.477
51.	I can easily picture moving objects in my mind.	.448
67.	My thinking is more "visual" than "verbal".	.437
4.	My powers of imagination are higher than average.	.433
54.	I do not form a mental picture of people or places when reading of them.	-.368
16.	I often use mental images or pictures help me remember things.	.363

61.	Thoughts are represented in my head in the of words.	-.348
20.	When thinking or talking to myself, I find that I don't use words for ideas and objects that I can visualize.	.319
14.	Most of my thoughts are verbal in nature.	-.310

FACTOR 3: WORD PERSON (6.5%)

60.	I have a strong nonverbal sense of things.	-.767
22.	I consider myself to be a "word" or "verbal" person.	.724
19.	I enjoy doing work that requires the use of words.	.507
68.	My thinking is more "verbal" than "visual".	.469
58.	Words are needed for conversation with others. Privately, I do not need to rely on words for thinking.	-.425
67.	My thinking is more "visual" than "verbal".	-.401
59.	When thinking, I use language and words much more than I use visual images.	.365
61.	Thoughts are represented in my head in the form of words.	.327
44.	I enjoy learning new words.	.318
14.	Most of my thoughts are verbal in nature.	.317

FACTOR 4: STRONG DREAMS (5.7%)

27.	I seldom dream.	-.851
32.	My dreams are extremely vivid.	.678
51.	I can easily picture moving objects in my mind.	.465
20.	When thinking or talking to myself, I find that I don't use words for ideas and objects that I can visualize.	-.384
4.	My powers of imagination are higher than average.	.347

40.	My day dreams are sometimes so vivid I feel as though I actually experience the scene.	.345

FACTOR 5: DIFFICULTIES EXPRESSING IN WRITING (4.7%)

52.	I can express myself more easily when I talk than when I write.	.819
46.	I can express myself more clearly when I write than when I talk.	-.796
43.	I can easily express myself in writing.	-.593
20.	When thinking or talking to myself, I find that I don't use words for ideas and objects that I can visualize.	.322

FACTOR 6: TWO THINGS ARE DISTRACTING (4.1%)

3.	I cannot listen to two things at the same time.	.768
63.	It is difficult for me to do more than one thing at a time	.661
49.	I can "turn off" noise or chatter in my environment so it does not bother or distract me.	-.625
36.	Even when someone is talking about something I am interested in, I find myself easily distracted.	.390
64.	I read rather slowly.	.347

FACTOR 7: VERBAL DIFFICULTIES (3.6%)

28.	I arrive at conclusions before I can explain why.	.840
38.	My thoughts and ideas tend to be so intertwined that I often don't know what order to present the ideas in when I speak.	.517
23.	When I talk, I tend to go off on tangents.	.497
62.	I prefer to read instructions about how to do something, rather than have someone show me.	-.486
4.	My powers of imagination are higher than average.	.368

20.	When thinking or talking to myself, I find that I don't use words for ideas and objects that I can visualize.	.337
36.	Even when someone is talking about something I am interested in, I find myself easily distracted.	.320

FACTOR 8: GOOD AT REMEMBERING (3.5%)

11.	It is sometimes difficult for me to remember names of things.	-.842
26.	I am usually good at remembering new peoples' names.	.726
13.	I retain the main ideas of what I hear or what I read, but I rarely remember the words used.	-.503
40.	My day dreams are sometimes so vivid I feel as though I actually experience the scene.	.401
33.	I cannot generate a mental picture of a friend's face when I close my eyes.	.319

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with verbal thinking. The fourth factor that emerged was "strong dreams". It was essentially the same as the "strong dreams" factor for the younger sample. It included items related to having many dreams, vivid dreams, and easily using imagery or having strong imagery during waking hours. The fifth factor was "hard time expressing". This included items related to having a difficult time expressing oneself in writing. The sixth factor, "two things are distracting", was also similar a factor in the younger sample. The young sample's factor was Doing Two Things at Once, and for the older sample, it emerged as Two Things are Distracting. The slightly different items suggest the older people feel distracted at times, and the

focus of the younger sample seems to be the ability to concentrate on one thing despite possible distractions. The seventh factor that emerged for the older sample was "verbal difficulties". This factor contained items relating to not easily explaining reasoning, thoughts being intertwined, and going off on tangents. The final interpretable factor concerned being "good at remembering". It contains items related to remembering names of people and things, faces, and retaining ideas.

The factors on these factor analyses are similar to those found by Paivio & Harshman (1983) on a factor analysis of a similar measure. This will be briefly discussed in the discussion section.

Primary Hypothesis

The results to the main hypothesis will be presented first for the younger sample, and then for the older sample. Before I discuss the particular results, I will describe the measures used and the scales created.

Younger Subjects

Description of Scales and Scores

Factor scores, were determined for all subjects on the first two factors. The first factor was a "verbal thinking" factor and the second was a "visual thinking" factor. Then a difference between these was obtained to get relative scores on the two factors. Similar difference

scores were used by Dabbs and Choo (1980). For purposes of discussion, this will be referred to as a factor-difference score. Hence, a high score on Factor #1 and a low score on Factor #2 yields a difference score that reflects an opposite cognitive style from a low score on Factor #1 and a high score on Factor #2. These difference scores, which now reflect cognitive styles (as defined by the reported difference between the two kinds of thinking), make up a scale called VISVERB. Positive VISVERB scores reflected more visual thinking, and negative scores reflected more verbal thinking.

In a similar manner, visual-verbal difference-scores were obtained using the two WAIS subtests, that is, the Block Design and Vocabulary Tests. The scores on these two tests were changed into z-scores and then the difference between the two tests was obtained for each individual. This new scale is called VOCABLOCK. A positive VOCABLOCK score indicated relatively more visual than verbal ability and hence, a visual style. Similary, a negative score indicated a more verbal style.

Richardson's Visualizer-Verbalizer Questionnaire (VVQ) was described in the literature review. Scores on some of the items were reversed so that when the scores on the included items were added, a high score indicated visual thinking.

The last cognitive style measure, SELFREP, is a scale based on the responses to two items on the questionnaire: "My thinking is more visual than verbal" and "My thinking

is more verbal than visual". Because it is based on direct responses to these questions, it portrays each subject's personal assessment of his or her cognitive style. Again, a positive score indicates a visual style and a negative score indicates a verbal style.

To briefly summarize the measures of cognitive style, VISVERB is based on the difference between the factor scores. VOCABLOCK is based on the differences between the individual's visual and verbal abilities (WAIS subtests). VVQ is the score on Richardson's test; and SELFREP is based on the self-reports of cognitive style.

One final scale, the AGESCALE, was created. The theory behind this scale was explained on page 65. The scale was specifically created by summing the scores to the following questions: 1) "My reasoning ability seems to get better as I get older," 2) "As I get older, my mind seems to function better than ever," 3) "I do not remember things as well as I used to," and 4) "I now have difficulty figuring things out which used to be easy for me." The signs to the last 2 questions were reversed so that a high score on all questions, and hence the entire scale, reflected a sense of decline with age.

Relationships among the Measures

The intercorrelations among all the measures were computed to shed light on the statistical domain of the two styles in question. For the younger sample, correlations

between Ravens Scores and other measures can be seen in Tables 8 and 9. Correlations between the cognitive style (visual-verbal) measures and the WAIS subtests are shown in Table 24. Correlations between the cognitive style measures can be seen in Table 5. Correlations between the cognitive style measures and the first 2 factors are shown in Table 6. Correlations between other measures for the younger sample are shown in Table 7.

TABLE 5

Intercorrelations among Cognitive Style (Visual-verbal) Measures

	VISVERB	VOCABLOCK	SELFREP	VVQ
VISVERB (factor scores)	----	.19*	.74**	.28**
VOCABLOCK (WAIS subtests)		----	.33**	.22*
SELFREP (2 items)			----	.42**
VVQ				

*p <.02
**p <.001

TABLE 6

Correlations between Factors 1 and 2 and the Cognitive Style Measures

	VISVERB	VOCABLOCK	SELFREP	VVQ
Factor 1	.71***	.24	.77***	.34***
Factor 2	-.71***	.04	-.11*	.06

* p <.02
*** p <.001

TABLE 7

Intercorrelations among other Measures

	Factor 1	Factor 2	Blocks	Vocab	Agescale
Factor 1	-----	.00	.00	.30***	.03
Factor 2		-----	.06	-.02	.04
Block Design			-----	.23**	-.04
Vocabulary				-----	-.17

* p <.006
** p <.001

Relationships between the Measures and Ravens

The first hypothesis predicted a positive relationship between verbalizing and performance on Ravens for verbal individuals, and a negative relationship on these measures for visual individuals. To get preliminary relationships, Pearson product-moment correlations were computed. This was done separately for the verbalizing and non-verbalizing groups. These results can be seen in Table 8.

TABLE 8

Intercorrelations Among Visual-Verbal Measures and Ravens, for both the Verbalizing Group and the Non-verbalizing group

	VISVERB	VOCABLOCK	VVQ	SELFREP
Verbalizing	-.21*	-.26**	-.19*	-.37***
Non-verbalizing	.14	.30*	.07	.43***

* p <.05
** p <.01
*** p <.001

Examination of these correlations reveals some significant relationships and also suggests which measures serve as the strongest predictors of the interactions, and therefore provided the strongest methods of dividing subjects into visual and verbal cognitive styles. The strongest correlations involved SELFREP, the subjects' self assessments of the visual or verbal nature of their thinking. However, it is possible that the subjects' responses to the two questions that determined their position on this scale were confounded by their reaction to the rest of the questionnaire. Therefore, in this investigation, this measure was considered to be less important than the more empirically derived measures.

The strongest empirically derived measure was VOCABLOCK, which was the cognitive style measure that was based on the WAIS subtests. These correlations between the cognitive style measures and scores on Ravens can be interpreted as meaning that when verbalizing while doing Ravens, verbal subjects did better than visual subjects. In contrast, when subjects did not verbalize, visual individuals did better than verbal individuals. This relationship will be further examined on pages 115-117.

For VISVERB, the measure based on the factors, the same relationship was significant for those who verbalized while solving Ravens Matrices. That is, verbal individuals did better than visual individuals. However, although the same trend appeared that was described in the analysis

using VOCABLOCK, this relationship was not significant for those who didn't talk. This suggests that the abilities tests were stronger predictors of the effects of verbalization than the factor scores.

When using Richardson's VVQ, the correlation with Ravens was almost significant in the verbalizing condition ($p < .056$), suggesting that although the effect was manifested in this scale, it was the weakest predictor. There was essentially no relationship between this measure and Ravens for those not verbalizing. Therefore, this measure will not be used in further analyses involving the first hypothesis.

Relationships between Factors and Measures

In order to examine the possibility that either visual thinking or verbal thinking (as opposed to a visual or verbal style score) could differentiate individuals who respond differently to the manipulation, correlations were computed between Ravens and the visual and the verbal factors and abilities, respectively, for both verbalizing and non-verbalizing groups. Results can be seen in Table 9.

TABLE 9

Intercorrelations Among Visual and Verbal Measures, and Ravens, for both the Verbalizing Group and Non-verbalizing Group

	Factor #1 Verbal	Factor #2 Visual	Block Design	Vocabulary
Verbalizing	.35***	.10	.13	.45***
Non-verbalizing	-.01	.23*	.60***	.26*

* $p < .05$
*** $p < .001$

Examination of these correlations suggests that for subjects who verbalize, those who do well on the Vocabulary test do better on Ravens. For subjects who do not verbalize on Ravens, those who do well on the Block Design do better. Similarly, subjects high on the verbal factor do better when they verbalize, and subects high on the visual factor do better when they do not verbalize.

Although these correlations suggest these relationships, analyses of variances did not reveal significant interactions for these measures. An analysis of variance (ANOVA) was computed examining scores on Ravens for the individuals high and low on the visual factor, in both the verbalizing and non-verbalizing conditions. The high and low groups were determined by dividing subjects based on their scores for the factors. All scores zero and above were considered high, and all those below zero were considered low. The visual factor by itself did not differentiate which people were helped. In other words,

people who were more visual, or less visual, were not affected differently by the act of verbalizing while doing Ravens. Likewise, the verbal factor did not discriminate between people who were helped by the intervention. The mean scores can be seen in Table 10.

It should be noted that all statistical analyses will be based on the subjects' scores on Ravens. Thus, whenever a mean is given, unless otherwise specified, it is the mean score of that particular group on Ravens. It should also be noted that, as mentioned, all scores on the other measures have been converted to standardized scores and will be reported accordingly.

TABLE 10

Mean Scores on Ravens (in the Verbalizing and Non-verbalizing Groups) for High and Low Verbal and High and Low Visual Younger subjects (Based on the Factor Scores)

	Factor 1		Factor 2	
	High Verbal	Low Verbal	High Visual	Low Visual
Verbalizing	18.84	16.84	18.23	17.40
Non-verbalizing	18.73	18.51	18.98	17.78

Of interest, students high and low on Factor 3, "trouble with words", were affected differently by the manipulation, $F(1,121)=4.70$, $p < .03$. When the sexes were examined separately, the relationship was not significant for females, but it was for males, $F(1,52)=6.64$, $p < .01$. Males who had more trouble with words did better not

verbalizing ($\overline{X}$=19.73) than verbalizing ($\overline{X}$=16.54), and males who had less trouble with words did better verbalizing ($\overline{X}$=19.58) than not verbalizing ($\overline{X}$=17.94).

To get some indication of whether Factor 3 was related to intelligence, Pearson product-moment correlations were computed between Factor 3 and the WAIS subtests. Factor 3 and the Vocabulary Test were significantly correlated ($r=.19$, $p < .02$). This correlation is not unexpected since both Factor 3 and the Vocabulary test strongly represent verbal aptitudes. The correlation between Factor 3 and the Block Design was not significant. The sum of the Block Design and Vocabulary scores was not significantly correlated with Factor 3. Thus, it can be concluded that intelligence is not related to Factor 3.

In order to examine whether the level of subjects' visual ability was related to the effectiveness of the manipulation, an analysis of variance was performed which examined scores on Ravens for individuals high and low on the Block Design Test for those verbalizing and not verbalizing. Although the mean of the Block Design was 40.83, the division into high and low groups was between 39 and 40. Scores higher than 40 include bonus points for very fast times. Scores under 40 are obtained if the ten designs are not correctly solved within the time limits. Forty is the score obtained when a subject correctly constructs all ten designs within the allowed time limit. Therefore, including those with a score of 40 in the low

visual group could obscure results. Results indicated that the Block Design itself did not significantly predict how individuals were affected by the act of verbalizing.

Another analysis of variance was computed to determine whether the scores on the Vocabulary Test were related to the intervention; in other words, to see whether those high or low on this test of verbal ability were affected differently by the act of verbalizing. The division into high and low groups was made between scores of 62 and 63 so that 50% of the sample was in each group. Scores on the Vocabulary Test did not significantly discriminate between the groups. The mean scores on Ravens for subjects high and low on the Block Design and the Vocabulary Test are shown in Table 11

TABLE 11

Mean Scores on Ravens for Subjects relatively High and Low on the Block Design and High and Low on the Vocabulary Test

	High Blocks	Low Blocks	High Vocab	Low Vocab
Verbalizing	18.34 (N=47)	17.00 (N=21)	19.17 (N=41)	16.04 (N=27)
Non-verbalizing	20.09 (N-32)	16.68 (N=25)	19.23 (N=22)	18.20 (N=35)

One interpretation of the negative results above is that neither the visual thinking, the verbal thinking, the visual ability, nor the verbal ability is a strong enough

discriminator. None of these, by itself, reflects the cognitive style. A person can be strong (or weak) on both factors, or have relatively equal abilities in the different areas. The concept of cognitive style specifically implies using one type of thinking as a predominant mode.

Thus, to further test the first hypothesis, subjects had to be divided into groups that consisted of individuals with visual and verbal styles. Two decisions had to be made. The first was which measure to use. It was decided that the analyses would be done using both factor scores and abilities scores. The second decision concerned the way to discern subjects with one of the two cognitive styles. Subjects who had both types of thinking in equal proportion had to be eliminated. According to the rationale of this study, their approach to problem solving would be more flexible, and consequently, less effected by the intervention.

Main tests of the Major Hypothesis

Thus, for the primary set of analyses, only subjects who were more clearly visual and verbal were used. For all these analyses testing the major hypothesis, three-factorial analyses of variance were performed with the three between-subject variables being sex, verbalizing or non-verbalizing on Ravens, and visual or verbal cognitive style. Several analyses were computed because of the various ways of dividing subjects into visual and verbal

groups. Overall, the main effects in these analyses were not significant. Neither visual nor verbal subjects performed significantly better on Ravens. Verbalizing and non-verbalizing subjects were also not significantly different on their performance on Ravens. Many of the interactions, however, were significant. These various interactions will now be described.

After a frequency distribution of ability-difference scores (VOCABLOCK) was examined, subjects were divided into visual and verbal groups by including only those subjects with scores more than one standard deviation from the mean. This ANOVA involved 41% of the subjects, and included 28 visual subjects and 23 verbal subjects. Mean scores on Ravens can be seen in Table 12. A summary of the results is shown in Table 13, and a graph indicating the interactions can be seen in Figure 1. There were no main effects. Results indicate a general tendency for visual subjects to be hurt by verbalizing and verbal people to be helped by verbalizing, $F(1,43)=11.37$, $p < .002$. Thus, using these scores, the first hypothesis was highly confirmed for all younger subjects.

TABLE 12

Mean Scores on Ravens for Visual and Verbal
Males and Females, Based on VOCABLOCK
(Differences in Abilities Tests)

	Visual	Verbal
Males		
Verbalizing	15.67 (N=3)	21.50 (N=2)
Non-verbalizing	21.00 (N=5)	19.00 (N=5)
Females		
Verbalizing	16.64 (N=11)	18.36 (N=11)
Non-verbalizing	19.67 (N=9)	17.00 (N=5)
Total Sample		
Verbalizing	16.43 (N=14)	18.85 (N=13)
Non-verbalizing	20.14 (N=14)	18.00 (N=10)

TABLE 13

Summary Table of the ANOVA, Based on Mean
Scores on Ravens, using VOCABLOCK
Scores above +1 and below -1

Source	df	MS	F
Cognitive Style	1	.91	.13
Verbalizing Condition	1	25.03	3.47
Sex	1	8.95	1.24
Style x Cond	1	82.07	11.37**
Style x Sex	1	10.38	1.44
Cond x Sex	1	1.66	.23
Style x Cond x Sex	1	6.85	.95

** $p < .002$

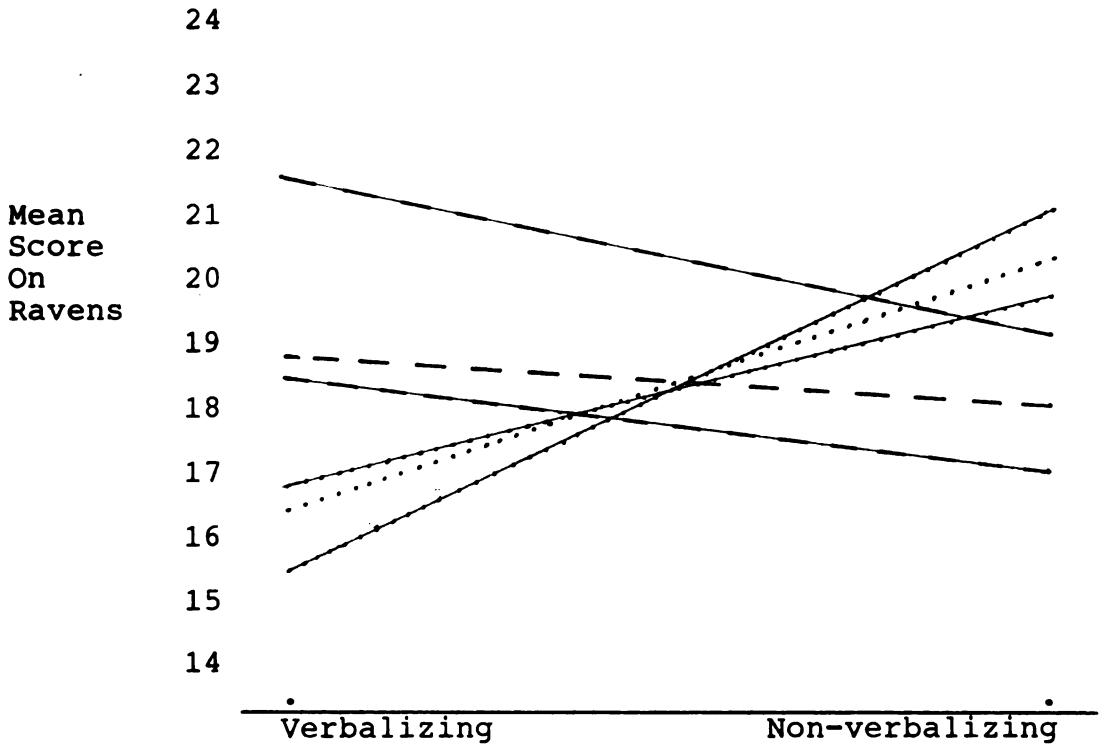

Figure 1. Mean Score on Ravens for Visual and Verbal Males and Females, in the Verbalizing and Non-verbalizing groups. Visual and Verbal groups were defined by scores on VOCABLOCK, at above +1 and below -1 SD. This ananysis includes 41% of the younger sample.

Males ———
Females ———
Total Sample ———

Visual.....
Verbal - - -

For the analysis based on the difference between the two factors (VISVERB), again, the division was at the point at which the difference scores were above or below one standard deviation of the mean. This included 50% of the sample and resulted in 37 in the visual group and 25 in the verbal group. The mean scores on Ravens are shown in Table 14, and a summary of the analysis is presented in Table 15.

TABLE 14.

Mean Scores on Ravens for Visual and Verbal Males and Females, Based on VISVERB (Differences in Factor Scores)

	Visual	Verbal
Males		
Verbalizing	18.00 (N=6)	20.00 (N=2)
Non-verbalizing	20.08 (N=13)	19.00 (N=5)
Females		
Verbalizing	15.14 (N=7)	19.38 (N=13)
Non-verbalizing	19.73 (N=11)	18.40 (N=5)
Total Sample		
Verbalizing	16.46 (N=13)	19.47 (N-15)
Non-verbalizing	19.92 (N=24)	18.70 (N=10)

In this analysis, there was a main effect of the Verbalizing Condition. Those not verbalizing did significantly better ($\bar{X}$=19.56, N=34) than those verbalizing ($\bar{X}$=18.07, N=28), $F(1,54)=4.59$, $p < .04$. One possible explanation for this is that because the younger sample was more visual than verbal, subjects did somewhat better when

not verbalizing. The Mean scores for the whole sample (see Table 1) suggested this same trend.

The interactions between cognitive style and verbalizing condition are shown in Figure 2. Again, there was a general tendency for visual subjects to be hurt by verbalizing and verbal people to be helped by verbalizing, $F(1,54)=9.06$, $p < .004$.

TABLE 15

Summary Table of the ANOVA, Based on Mean Scores on Ravens, using VISVERB scores above +1 and below -1

Source	df	MS	F
Cognitive Style	1	13.80	1.88
Verbalizing Condition	1	33.71	4.59*
Sex	1	6.78	.92
Style x Cond	1	66.49	9.06**
Style x Sex	1	1.51	.21
Cond x Sex	1	8.90	1.21
Style x Cond x Sex	1	4.27	.58

* $p < .04$
** $p < .004$

To get a measure of self-reported cognitive style, scores were obtained from the differences between the responses to the last two items on the questionnaire, "My thinking is more verbal than visual" and "My thinking is

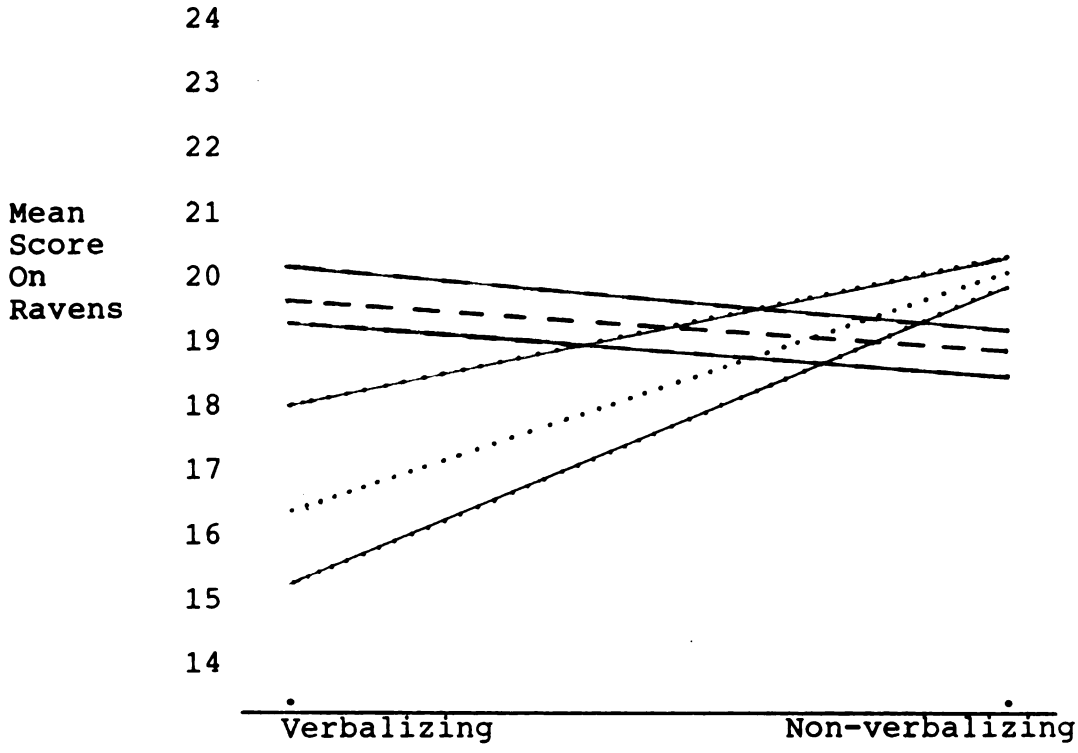

Figure 2. Mean Score on Ravens for Visual and Verbal Males and Females, in the Verbalizing and Non-verbalizing groups. Visual and Verbal groups were defined by scores on VISVERB, at above +1 and below -1 SD. This analysis included 50% of the younger sample.

Males ————
Females ————
Total Sample ————

Visual.....
Verbal - - -

more visual than verbal". The division into visual and verbal groups involved 57% of the total sample, and included those individuals who had the maximum of a 4-point difference between their responses to these items. Forty seven visual and 30 verbal subjects were involved in this analysis. These subjects answered true or false to one of these items, with the opposite response for the other item. The other 43% had a 3 point or less difference on their responses to these two items, indicating that they couldn't definitely describe their thinking as more visual or verbal (5% had a 3-point, 25% had a 2-point difference, 2% had a 1-point difference and 11% had no difference). The correlation between these two items was -.87, $p < .001$. The means scores on Ravens for the subjects involved in this analysis can be seen in Table 16. A summary of the ANOVA is shown in Table 17.

In this analysis, there were 2 main effects. First, subjects who reported their cognitive style to be more verbal did significantly better ($\bar{X}$=19.21, N=30) than those who reported their thinking to be more visual ($\bar{X}$=18.15, N=47), $F(1,69)=6.59$, $p < .01$. Second, males did significantly better on Ravens ($\bar{X}$=19.41, N=32) than females ($\bar{X}$=18.09, N=45), $F(1,69)=4.75$, $p < .04$).

For the total sample, the interaction between this measure and the verbalizing or non-verbalizing condition was significant, $F(1,69)=5.16$, $p < .026$. The interactions are shown in Figure 3.

TABLE 16

Mean Scores on Ravens for Visual and Verbal
Males and Females, Based on
Self-reports of Cognitive Style

	Visual	Verbal
Males		
Verbalizing	17.90 (N=10)	20.75 (N=4)
Non-verbalizing	19.62 (N-13)	20.80 (N=5)
Females		
Verbalizing	15.60 (N=10)	19.13 (N=15)
Non-verbalizing	18.79 (N=14)	18.00 (N=6)
Total Sample		
Verbalizing	16.75 (N=20)	19.47 (N=19)
Non-verbalizing	19.19 (N=27)	19.27 (N=11)

TABLE 17

Summary Table of the ANOVA, Based on Mean
Scores on Ravens, using SELFREP
Scores of + 4 or - 4

Source	df	MS	F
Cognitive Style	1	55.82	6.59*
Verbalizing Condition	1	31.92	3.77
Sex	1	40.17	4.75*
Style x Cond	1	43.69	5.16*
Style x Sex	1	1.61	.19
Cond x Sex	1	1.43	.17
Style x Cond x Sex	1	6.83	.81

* $p < .03$

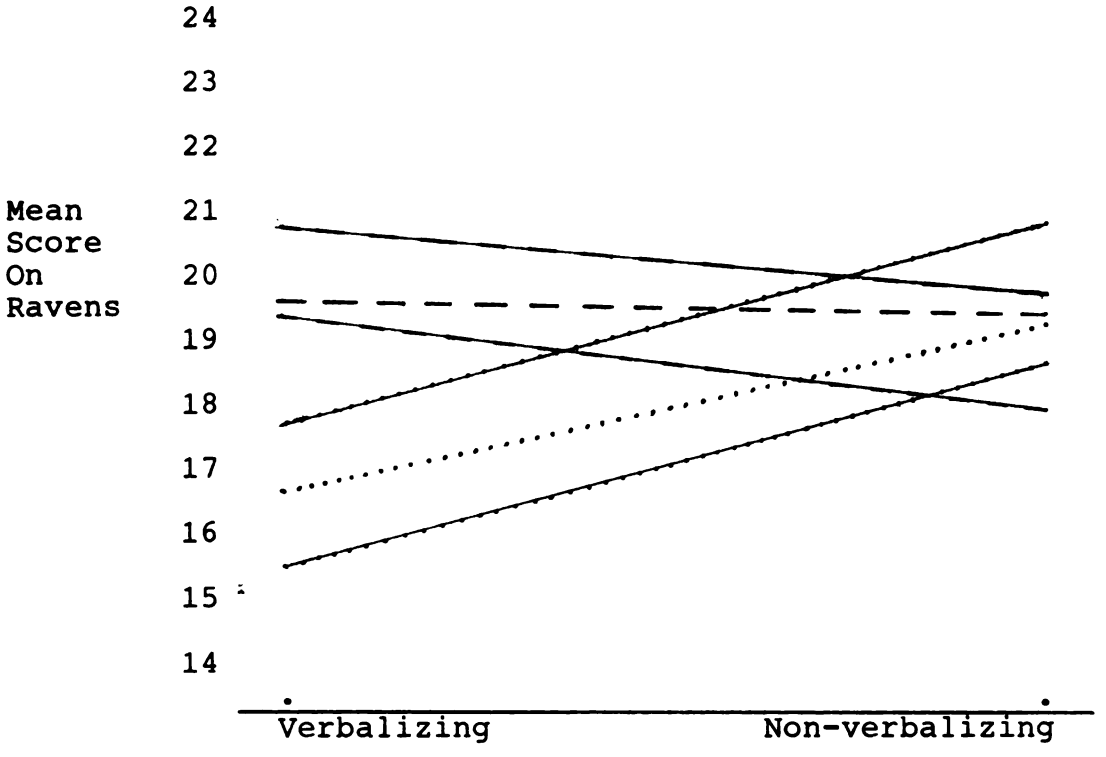

Figure 3. Mean Score on Ravens for Visual and Verbal Males and Females, in the Verbalizing and Non-verbalizing groups. Visual and Verbal groups were defined by maximum SELFREP scores (self-assessments based on answers to 2 questions). 57% of the sample is included.

Males ————
Females ————
Total Sample ————

Visual.....
Verbal - - -

The primary hypothesis of this investigation was confirmed by the analyses just described. Regardless of which measure was used to divide subjects into visual and verbal groups, the results demonstrated that verbalizing helped verbal subjects solve Raven's Matrices and it had a detrimental effect on the ability of more visual subjects to solve Raven's Matrices.

To include a greater number of subjects in the analyses and to broaden the generalizability of the findings, the last three analyses were repeated after widening the parameters of the divisions into visual and verbal groups.

For the analysis based on the Block Design and Vocabulary test, the division into visual and verbal groups was changed to exclude only those less than plus or more than minus .5 standard deviations. This analysis involved 66% of the participants, including 42 visual and 40 verbal subjects. The mean scores on Ravens can be seen in Table 18, and a summary of the ANOVA is presented in Table 19. There were no main effects. The interaction between verbalizing condition and cognitive style, which can be seen in Figure 4, was significant $F(1,89)=9.33$, $p < .003$. When separate ANOVA's were computed to examine whether these interactions were signicant for each sex separately, the same interactions were significant for males, $F(1,42)=4.28$, $p < .04$, and for females, $F(1,43)=5.74$, $p > .02$. Thus, again, using individual differences in abilities scores, the main hypothesis was highly confirmed for all groups.

TABLE 18

Mean Scores on Ravens for Visual and Verbal
Males and Females, Based on VOCABLOCK
(Differences in Abilities Tests, +.5, -.5 SD)

	Visual	Verbal
Males		
Verbalizing	17.12 (N=8)	19.25 (N=8)
Non-verbalizing	20.40 (N=10)	17.73 (N=11)
Females		
Verbalizing	16.54 (N=13)	18.27 (N=15)
Non-verbalizing	19.27 (N=11)	17.50 (N=6)
Total Sample		
Verbalizing	16.76 (N=21)	18.61 (N=23)
Non-verbalizing	19.81 (N=21)	17.65 (N-17)

TABLE 19

Summary Table of the ANOVA, Based on Mean
Scores on Ravens, using VOCABLOCK
Scores above .5 and below -.5

Source	df	MS	F
Cognitive Style	1	.03	.00
Verbalizing Condition	1	19.85	2.40
Sex	1	5.85	.71
Style x Cond	1	80.76	9.75**
Style x Sex	1	.21	.03
Cond x Sex	1	.02	.00
Style x Cond x Sex	1	2.00	.24

** $p < .003$

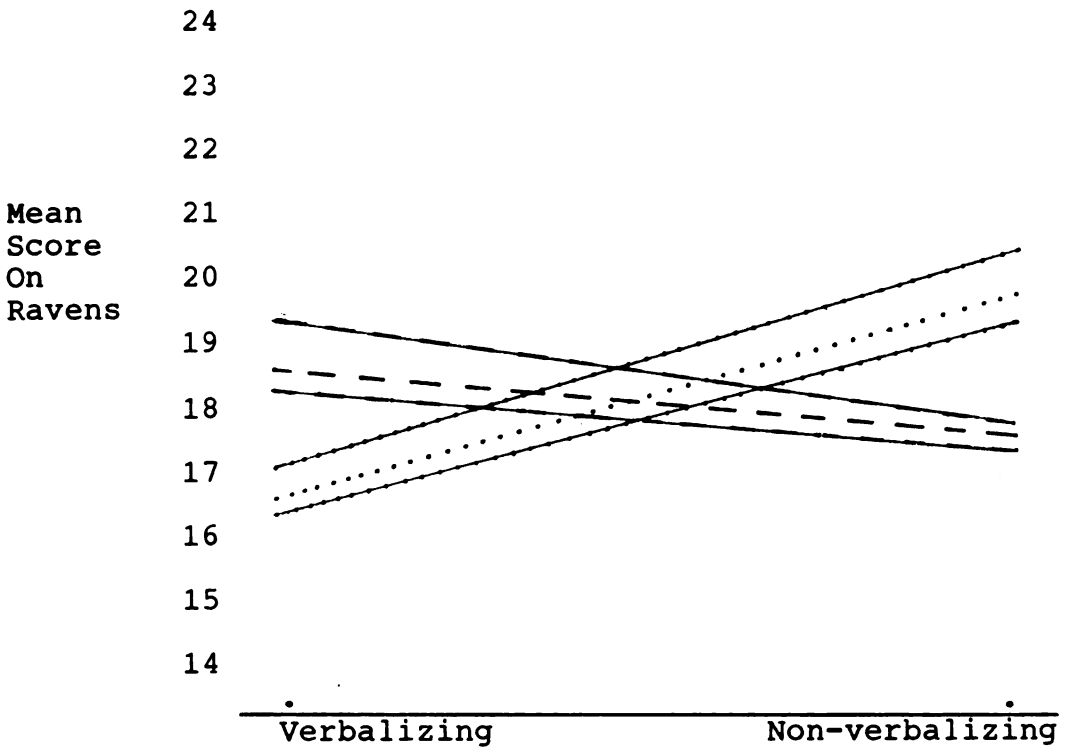

Figure 4. Mean Score on Ravens for Visual and Verbal Males and Females, in the Verbalizing and Non-verbalizing groups. Visual and Verbal groups were defined by scores on VOCABLOCK, at above and below .5 SD. This analysis includes 66% of the younger sample.

Males ———
Females ————— Visual.....
Total Sample ——— Verbal - - -

For the next ANOVA using the factor-difference scores (VISVERB), visual and verbal groups were defined as those with scores of plus or minus .5. This included 73% of the sample. None of the results was significant. The division of subjects into visual and verbal groups based on their self reports (their responses to the last two items) was changed for the next ANOVA. The true-false scale (with true having a value of 1 and false having a value of 5) allowed a maximum difference score of 4. This difference of 4 was used in the previous analysis. For the present analysis, a difference of 3 (or more) was used. Using this division, again, none of the results of the ANOVA wassignificant.

It is noteworthy that the measure that appears to yield the strongest confirmation of the main hypothesis does not yield any main effects, and the two weaker measures, VISVERB and SELFREP, each yield different main effects. The fact that no main effects were significant in any two analyses suggests they may be artifactual and related to either one of the measures or the distribution of subjects in the groups.

Generalizing to the Population at Large. In many of the analyses testing the major hypothesis, continuous variables were dichotomized, and part of the available subject population was excluded. To get a sense of how much information was sacrificed using ANOVA's, and to determine more specifically which were the strongest

predictors of performance on Ravens, multiple correlations were computed. Subject's performance on Ravens for those verbalizing and for those not verbalizing was predicted from the Block Design and Vocabulary scores, as well as Factors 1 and 2. Results are shown in Tables 20 and 21.

TABLE 20

Contributions of the Block Design and Vocabulary Tests in predicting Ravens for both the verbalizing and Non-verbalizing Conditions

Verbalizing				Not Verbalizing			
Variable	B Value	r	p	Variable	B Value	r	p
Vocab	.16	.44	.001	Vocab	.03	.12	.267
Blocks	.04	.06	.617	Blocks	.25	.57	.001
Constant	6.49		.075	Constant	6.52		.007

As can be seen in Table 20, there is a much greater importance of the Vocabulary Test ($r=.44$, $p < .001$) than the Block Design Test ($r=.06$, $p < .62$) in determining performance on Raven's while students are verbalizing ($r^2=.21$, $F(2,65)=8.58$, $p < .001$). In contrast, in the nonverbalizing group, the exact opposite is true. The correlations reflect a much greater importance of the Block Design Test ($r=.57$, $p < .001$) than the Vocabulary Test ($r=.12$, $p < .27$) in determining performance of Raven's while not verbalizing ($r^2=.37$, $F(2,54)=15.99$, $p < .001$).

Multiple correlations computed by examining the first two factors indicated that these two factors were not as strong predictors of performance on Ravens as the abilities

tests. As can be seen from the different correlations in the verbalizing vs. the nonverbalizing groups (in Table 21), there is a much greater importance of Factor 1 ($r=-.35$, $p < .003$) than Factor 2 ($r=-.11$, $p < .36$) in determining performance on Raven's during verbalizing ($r^2=.133$, $F(2,65)=4.99$, $p < .01$). In contrast, the correlations suggest greater importance of Factor 2 ($r=-.25$, $p < .07$) than Factor 1 ($r=-.08$, $p < .57$), in determining performance of Raven's while not verbalizing, although these differences were not significant ($r^2=.06$, $F(2,54)=1.72$, $p < .19$).

TABLE 21

Contributions of Factor 1 and Factor 2 in predicting Ravens for both the verbalizing and non-verbalizing conditions

Verbalizing				Not Verbalizing			
Variable	B Value	r	p	Variable	B Value	r	p
Factor 1	-1.11	-.35	.001	Factor 1	-.21	-.08	.587
Factor 2	-.43	-.11	.359	Factor 2	-.72	-.25	.070
Constant	17.63		.001	Constant	18.54		.001

In the ANOVAs testing the main hypothesis, difference scores of various ranges were used to differentiate visual and verbal thinkers. To further investigate the applicability of the findings to the population at large, a two-factorial ANOVA was computed in which all subjects were included. VOCABLOCK scores were selected because previous

results suggested that this measure was the strongest measure of cognitive style. The analysis revealed the same interactions as the earlier analyses. Verbal subjects performed better when verbalizing, and visual subjects performed better when not verbalizing ($F(1,121)=6.21$, $p < .01$). The mean scores for the groups are presented in Table 22, and the results of this analysis are summarized in Table 23. The fact that this analysis, which includes all subjects, yields significant results, suggests the generalizability of the major findings of this investigation to the population at large.

TABLE 22

Mean Scores on Ravens for Visual and Verbal Males and Females based on VOCABLOCK Scores and including all Subjects

	Visual	Verbal
Males (N=56)		
Verbalizing (N=25)	17.08 (N=12)	18.85 (N=13)
Non-verbalizing (N=31)	19.40 (N=15)	18.25 (N=16)
Females (N-69)		
Verbalizing (N=43)	17.10 (N=20)	18.56 (N-23)
Non-verbalizing (N=26)	19.00 (N=13)	17.69 (N=13)
Total Sample (N=125)		
Verbalizing (N=68)	17.09 (N-32)	18.66 (N=36)
Non-verbalizing (N=57)	19.21 (N=28)	18.00 (N=29)

* $p < .01$

TABLE 23

Summary Table of the ANOVA, Based on Mean Scores on Ravens, based on VOCABLOCK Scores

Source	df	MS	F
Cognitive Style	1	2.80	.29
Verbalizing Condition	1	14.17	1.46
Style x Cond	1	60.12	6.21*

* $p < .01$

Relationship between Overall Performance and the Effects of the Intervention

Further analyses were computed to address two additional and related issues. These issues concern the influence of overall performance and the question of how individuals who are high on both verbal and visual thinking differ in their responses to the treatment than those low on both types of thinking.

To address the question of overall performance more directly, a measure was created by summing the subjects' standardized scores on the Block Design and Vocabulary Test. For ease of discussion, this new measure is referred to here as 'intelligence'. Then, a three-factorial ANOVA was computed with the between-subject variables being cognitive style, verbalizing or non-verbalizing condition, and intelligence. There was one significant main effect and one significant interaction. As would be expected,

this new measure of intelligence was significantly related to performance on Ravens. Those who had higher intelligence had higher scores on Ravens ($\bar{X}$=19.25, N=63) whereas those with lower intelligence had lower scores on Ravens ($\bar{X}$=17.19, N=62), $F(1,117)=17.80$, $p < .001$. The significant interaction was the same as in previous analyses. That is, visual subjects performed much better on Ravens when not talking and verbal subjects performed much better when they were talking, $F(1,117)=8.24$, $p < .005$.

One problem with using a difference score is that individuals high on both abilities or on both kinds of thinking are given similar scores as those low on both. To determine whether those subjects who were approximately equally high or equally low in the two types of thinking differed in their responses to the treatment, additional analysis were computed. The measures involved in these new analyses are subject's scores on the Block Design and the Vocabulary Test. Subjects whose standardized scores in both the Block Design and Vocabulary Test were above .7 were considered 'high' in both. Those whose scores were both below -.7 were considered 'low'. A two-factorial ANOVA was then computed with the between-subjects variables being verbalizing or non-verbalizing condition and high or low on the abilities tests. As would be expected, there was a significant main effect for those high and low on the tests. Those high on the WAIS tests performed significantly better on Ravens ($\bar{X}$=20.67, N=15) than those

low on the WAIS tests ($\bar{X}$=15.22, N=9), F(1,20)=31.23, p <.001. However there was no significant interaction. Neither group reacted significantly more to the treatment.

To determine whether the treatment alone significantly affected individuals who had no particular cognitive style (as measured by the WAIS), t-tests were computed for those subjects who were high in both abilities, to see if there were signficant differences between those talking and those not talking. There were no significant differences. T-tests for those low in both abilities also revealed no significant differences. This suggests, as does the other results reported, that the act of verbalizing, by itself, does not significantly affect performance on Ravens. This has been demonstrated for the whole sample, for those high in both kinds of abilities, and for those low in both kinds of abilities. The effects of verbalizing are evident only when the cognitive style of the subjects is considered.

Relationship between WAIS subtests and Cognitive Style

One of the expectations in this investigation was the positive relationship between abilities and cognitive style. The Block Design and Vocabulary Tests were expected to be representative of visual (or visuo-spatial) and verbal abilities, respectively. To examine the relationships between these two WAIS subtests and the other cognitive style measures, several Pearson product-moment correlations were computed. These correlations can be seen

in Table 24. It should be noted that VOCABLOCK was not included because this scale had been defined by scores on these WAIS subtests and was therefore not independent.

Table 24

Intercorrelations among the Visual and Verbal Measures and the WAIS Subtests for Younger Subjects

	Block Design	Vocabulary
Factor 1 (Verbal)	.00	.30***
Factor 2 (Visual)	.06	-.02
VISVERB**	-.04	.20*
VVQ	.07	.34***
SELFREP	-.05	.38***

*p <.01
***p <.001
**Scores were reversed so a high score is more verbal

The verbal ability measure, the Vocabulary Test, was significantly related to all the measures of verbal thinking and verbal style. The correlations between the Block Design and the measures of visual thinking or visual style however, were not significant.

To further examine this relationship between cognitive style and cognitive abilities, t-tests were computed comparing the Block Design and the Vocabulary test scores for visual and verbal subjects. For these analyses, visual and verbal subjects were defined by two cognitive style measures: VISVERB and SELFREP. Subjects with VISVERB

scores above and below one standard deviation from the mean were compared. T-tests were computed for SELFREP scores for those subjects who responded with a definite cognitive style; that is, endorsing one kind of thinking as true, and the other as false. Mean scores for the groups can be seen in Table 25. Again, there were significant differences between visual and verbal individuals on the Vocabulary Test, both when using SELFREP, $t(75)=3.77$, $p < .001$, and when using VISVERB, $t(60)=-2.33$, $p < .02$. There were no significant differences on the Block Design.

Table 25

Mean Scores on the Vocabulary Test and Block Design for Visual and Verbal Younger Subjects Using more extreme SELFREP and VISVERB scores as Cognitive Style Measures

	VISVERB		SELFREP	
	Verbal	Visual	Verbal	Visual
Block Design	41.76	41.00	65.92	60.16*
Vocabulary	40.70	40.50	67.40	58.40***

*$p < .02$
***$p < .001$

Older Subjects

The correlation between the cognitive style measures and Ravens for the verbalizing and non-verbalizing groups can be seen in Table 26. The scales are the same as those for the younger subjects. The only difference is the absence of the VOCABLOCK, which could not be created for the older subjects because they did not take the WAIS

subtests. As with the younger subjects, VISVERB and SELFREP were created from the difference scores using the differences between the first two factors ("verbal thinking" and "visual thinking" and the last two items ("My thinking is more visual than verbal" and "My thinking is more verbal than visual"). Although the correlations suggest relationships similar to those reported in the results from the younger sample, none of the relationships was significant.

TABLE 26

Intercorrelations among Cognitive Style Measures and Ravens, for both Verbalizing and Non-verbalizing Older Subjects

	VISVERB	SELFREP	VVQ
Verbalizing	-.26	-.31	-.16
Non-verbalizing	.05	.15	-.06

The correlations between the factors and scores on Ravens are shown in Table 27. Again, none of the correlations was significant. However, a trend similar to results from the younger sample can be observed for those verbalizing while solving Ravens. Performance on Ravens was related to these two factors in opposite ways. The positive relationship with the verbal factor (.21) suggests verbalizing helped those, as compared to the negative relationship for the visual factor (-.16), which suggests that verbalizing hurt, or did not help these people. But still, these are only non-significant trends.

TABLE 27

Correlations Between Ravens and the Verbal and the Visual Factor, for Verbalizing and Non-verbalizing Older Subjects

	Factor 1 Verbal	Factor 2 Visual
Verbalizing (N=22)	.21	-.16
Non-verbalizing (N=20)	.14	.21

For the older sample, only factor scores and self-assessments were available as cognitive style measures. The between-subjects variables in these 2-factorial ANOVA's were verbalizing or non-verbalizing on Ravens and cognitive style. For the ANOVA using the factor-difference scores, the subjects were divided into visual and verbal groups with scores above one and below one standardized unit on VISVERB. This analysis included 50% of the sample that participated in the experimental portion of the study. None of the results were significant. However, it was observed that males and females had very different mean scores on Ravens. In addition to these apparent differences, because there were only 4 men in the sample, the men's scores were deleted and the ANOVA was computed for older women only. The analysis examined the relationship between the visual and verbal factor-difference scores for women in the verbalizing and non-verbalizing conditions. Although the means scores for the

women (which are shown in Table 28) suggest a trend, the results were not significant.

TABLE 28

Mean Scores on Ravens for Visual and Verbal Older Women, Based on VISVERB, (Differences in Factor Scores)

	Verbal	Visual
Verbalizing	33.00 (N=6)	28.29 (N=7)
Non-verbalizing	26.00 (N-1)	31.33 (N=3)

When the relationship between SELFREP and Ravens was examined for older subjects with a difference score of 3 or more, the analysis of variance revealed no significant differences.

Thus, the main hypothesis could not be confirmed for older subjects in any of the analyses. This lack of findings was most likely due to the small total number of participants (42) in the experimental groups for the older subjects.

Development of a Measure

One of the major goals in this study was to develop a measure for discerning visual or verbal styles of thinking. To this end, as described on p. 63-64, a 68-item, Likert-format, true-false test was developed. This questionnaire included items concerning cognitive habits, preferences and aptitudes.

Validity

The validity of this newly created measure was examined two ways. First, the factor structures were examined. Although there were some different loadings on the factors, and a few additional items for the older sample, both analyses yielded a "verbal thinking" factor first, and a strong "visual thinking" factor as the second factor that emerged. The "verbal thinking" factor for the older sample is combined with "good verbal expression" and is not as purely a measure of verbal thinking. Still, these results do offer support to the face validity of the measure. High loadings on these factors do appear to reflect the tendency to think verbally or visually. The factors with the item loadings can be seen in the Tables 3 and 4.

If the new instrument measures the visual-verbal cognitive style, and if other assumptions about the nature of these thinking styles holds true, then people who receive varying scores on it should behave differently when told to verbalize in a problem-solving situation. Thus, the second test of the validity of the measure is whether the factors which result predict the effects of the manipulation. In other words, using the results of this new instrument, is the main hypothesis significant? As described, this hypothesis was significant, lending more support for the validity of the measure.

Reliability

The reliability of the new instrument was tested by doing a split sample factor analysis. The younger subjects were divided into two groups (odd and even numbers), and two separate factor analyses were done. The first three factors of the two factor analyses were similar, but not identical. The themes were similar, and the items loading on them were similar. However, there were several items that differed on each of the first three factors, giving a slightly different 'flavor' to each factor. These results can be seen in Table 29. It should be noted that the Table contains shortened versions of the items. A list of the complete items can be seen in Appendix A.

There were many differences in the remaining factors. Some had similar themes, such as being "good at expressing" or being able to "do two things at once", but factors were in different orders. Other factors were different entirely. Each analysis had some factors in common with the factor analysis for the entire sample, but that didn't appear on both factor analyses when the sample was split. These results are shown in Table 30.

In another attempt to examine the reliability, Cronbach's alpha was computed to determine the internal consistency for each of the first two factors. These coefficient alphas were computed for 5, for 6, for 7, and for 8 items for Factor 1 and for Factor 2. The alphas can be seen in Table 31. According to Nunnaly (1970) .3 or .4 reflects low reliability, whereas .85 reflects very good

TABLE 29

Split Sample Factor Analysis: First Three Factors, with Items Loading over .3. The Table Reports Shortened Versions of the Items

FACTOR 1 - VERBAL THINKING

Sample 1		Sample 2	
67	Visual thinking -.837	68	Verbal thinking .832
68	Verbal thinking .821	67	Visual Thinking -.790
59	Use language for tht .730	59	Use lang. for tht .735
61	Thoughts in words .725	61	Thoughts in words .708
14	Thoughts are verbal .610	55	Vis images of thts -.568
60	Nonverbal sense -.586	58	Don't need words -.546
58	Don't rely on words -.561	45	Think in pictures .413
22	Word person .435	14	Thoughts are verbal .364
45	Think in pictures -.331	60	Nonverbal sense -.329

FACTOR 2

EASY TIME WITH WORDS		ENJOY WORDS	
Sample 1		Sample 2	
57	Expr thts clearly .813	19	Enjoy words .709
65	Translat. thts easy .699	53	Think of synonyms .681
56	Can explain solution .664	44	Enjoy learn. words .667
50	Hard to connect wds -.593	29	Good verbal fluency .608
38	Thoughts intertwined -.558	25	Don't incr vocab -.576
29	Good verbal fluency .448	22	Word person .551
22	Word person .434	13	Retain ideas -.492
9	Rem. details I read .424	9	Rem. details I read .478
53	Think of synonyms .383	43	Writing is easy .379
43	Writing is easy .380	56	Can explain solution .361
21	Trouble expressing -.376	37	Aware of detail .343
63	Hard to do 2 things -.371	50	Connect words-hard -.333
19	Enjoy work with words .320		
3	Can't hear 2 things -.320		

FACTOR 3 - VISUAL THINKING

Sample 1		Sample 2	
55	Vis. images of thts .715	16	Use pics to remember .786
45	Think in pictures .673	10	Solve probs w/ pics .704
34	Image complex ideas .659	45	Think in pictures .694
1	Image face on phone .595	42	Solution using pics
18	Thoughts in images .561	18	Thoughts in images .567
42	Solution using pics .559	51	Picture moving obj. .362
10	Solve probs with pics .555		
16	Use pics to remember .512		
54	No images when read -.468		
40	Daydreams are vivid .405		
51	Picture moving obj .385		
28	Can't explain concl. .334		

TABLE 30

Split Sample Factor Analysis: Remainder of the Factors, with Items Loading over .3. The Table Reports Shortened Versions of the Items

Sample 1		Sample 2	
4: DISLIKE WORK WITH WORDS		4: EXPRESSION IS EASY	
25	Don't incr. vocab. .737	65	Translating easy .738
30	Must reread passages -.693	57	Express thts clearly .685
64	Read slowly .647	50	Hard to connect wds -.480
44	Enjoy learning wds -.465	29	Good verbal fluency -.466
39	Read a lot .464	21	Trouble expressing -.453
29	Good verbal fluency -.370	43	Write easily .434
17	More logical -.332	38	Thts intertwined -.397
		22	Word person .358
5: EASY WRITTEN EXPRESSION			
46	Written expression .863	5: CAN DO TWO THINGS	
52	Talking expression -.866	63	2 things is hard -.794
43	Write easily .627	41	Watch TV & do things .742
39	Read a lot .339	3	Can't hear 2 things -.607
		37	Aware of details .506
6: RETAIN DETAILS		49	Can "turn off" noise .421
		64	Read slowly -.317
6	Remember new names .858		
1	Hard to rem. things -.611	6: STRONG DREAMS	
7	Aware of detail .512		
13	Retain idea not word -.325	32	Vivid dreams .779
		15	Daydreams hazy -.728
7: LOGICAL, ORDERED		4	High imagination .526
		27	Seldom dream -.516
17	More logical .720	40	Daydreams vivid .507
28	Can't explain concl. -.529		
63	Hard to do 2 things .447	7: EASY WRITTEN EXPRESSION	
3	Can't listen 2 things .362		
24	Images don't pop up .320	52	Talk more easily -.895
		46	Write more easily .880
8: DON'T USE PICTURES		43	Write easily .480
5	Don't believe in pics .797	8: READING DIFFICULTIES	
10	Solve probs with pics .510		
54	No images when reading .465	30	Reread passages .667
		39	Read a lot -.633
9: CAN DO TWO THINGS		64	Read slowly .542
		25	Don't incr vocab .379
41	Watch TV & do things .838	9	Rem. details read -.375
49	Can "turn off" noise .418	56	Explain solution .364
63	Do 2 things is hard -.378		
3	Can't hear 2 things -.335		

reliability. Accordingly, Factor 1 reflects fairly high reliability, especially when smaller number of items are included. The reliability of Factor 2 reflects moderate reliability.

TABLE 31

Coefficient alphas for varying numbers of items for Factor 1 and Factor 2. N=361

	Alpha for Factor 1	Alpha for Factor 2
5 items	.8536	.3856
6 items	.8582	.4806
7 items	.7712	.5588
8 items	.7848	.6162

In sum, these results suggest only moderate reliability for the measure. Whether this is a result of the small sample size or a weak measure cannot be determined.

Minor Hypotheses - Group Differences

Sex Differences

Sex differences could only be examined in the younger sample because of the small number of men in the older sample. The prediction was that there would be sex differences and that these would reflect a greater spatial inclination for men, and a greater verbal inclination for women. T-tests were computed to determine the differences between the sexes on the 68 items.

The results, as presented in Table 32, do not provide evidence in support of the hypothesis. There were no clear

TABLE 32

Sex Differences on the Items
for the Younger Sample (N=361)*
(207 Females and 154 Males)

Items which were more True for Males	Means M/F	S.D. M/F	t	p
4. Good imagination	1.89 2.33	1.33 1.53	-2.88	.004
11. Hard to remember things	2.57 3.10	1.61 1.69	-3.01	.003
17. More logical	2.20 2.78	1.52 1.63	-2.99	.003
27. Seldom dream	4.15 4.45	1.40 1.22	-2.16	.031
29. Good verbal fluency	2.25 2.69	1.41 1.51	-2.83	.005
33. Can't picture face	4.62 4.80	.90 .65	-2.20	.028
42. Solution using pictures	1.84 2.3	1.12 1.43	-3.32	.001
56. Can explain solution	1.81 2.10	1.14 1.38	-2.00	.046
Items which were more true for Females				
26. Remember new names	3.56 2.93	1.58 1.71	3.56	.001
31. Prefer written descript.	3.38 2.68	1.65 1.67	3.99	.001
39. Read a great deal	3.28 2.57	1.64 1.57	4.19	.001
40. Daydreams are vivid	2.69 2.23	1.60 1.56	2.75	.006
41. Watch TV and do things	3.04 2.39	1.70 1.66	3.66	.001

*lower score is more true

trends in the types of items that are more true for either males or females.

Sex differences were also examined on the eight interpretable factors. There were two factors in which males and females differed. In Factor 2 ("visual thinking") the mean score for males (.1728) was significantly higher than the mean score for females (-.1286) indicating more visual thinking for males, $t(359)=-2.86$, $p < .004$. This finding is consistent with other research indicating a stronger spatial orientation for males. Females were significantly higher (.1153) than males (-.1550) on Factor 6 ("Strong Dreams"), suggesting that females experience stronger dreams than males, $t(359)=2.56$, $p < .01$

There were no overall sex differences indicating different reactions to the manipulation.

Age Differences

Even though age differences were potentially confounded by ethnicity, education and sampling procedures, the older and younger age groups were examined to see whether any striking differences appeared. Age differences were examined for the 68 items. Results of the t-tests can be seen in Tables 33 and 34. Observation of the items suggests two main themes. First, most of the items which were more true for the younger sample reflected visual thinking or spatial abilities, whereas most of the items

TABLE 33

Age Differences on the Cognitive and Age Items - Items more True for Older Subjects*
361 Younger and 77 Older Subjects

Items more True for** Older Subjects	Means Young/Old	S.D. Young/Old	t	p
3. Can't listen to 2 things	3.23 / 2.42	1.67 / 1.68	3.84	.001
5. Don't believe in pics	4.65 / 4.32	.86 / 1.28	2.70	.007
11. Hard to remember things	2.88 / 1.77	1.67 / 1.33	5.46	.001
12. Hard to assemble	4.00 / 3.03	1.45 / 1.84	5.08	.001
13. Retain ideas, not words	2.29 / 1.84	1.51 / 1.27	2.42	.016
14. Thoughts are verbal	2.83 / 2.34	1.66 / 1.66	2.40	.017
15. Daydreams are hazy	4.04 / 3.49	1.42 / 1.62	2.98	.003
19. Enjoy work with words	2.52 / 1.66	1.56 / 1.31	4.47	.001
22. Word person	2.77 / 2.18	1.62 / 1.62	2.89	.004
24. Images don't pop up	3.67 / 2.97	1.56 / 1.71	3.50	.001
27. Seldom dream	4.32 / 3.61	1.31 / 1.71	4.08	.001
29. Good verbal fluency	2.50 / 2.04	1.49 / 1.46	2.49	.013
31. Prefer written descript.	2.98 / 2.03	1.70 / 1.50	4.56	.001
33. Can't picture face	4.72 / 4.48	.77 / 1.07	2.29	.022

Items more True for Older Subjects	Means Young/Old	S.D. Young/Old	t	p
35. Don't remember as well	3.86 1.99	1.55 1.53	9.63	.001
39. Read a great deal	2.87 1.81	1.64 1.40	5.30	.001
43. Writing is easy	2.26 1.84	1.51 1.38	2.19	.029
44. Enjoy learning words	1.76 1.27	1.20 .79	3.40	.001
46. Written expression good	3.10 2.56	1.66 1.63	2.62	.009
54. No images when reading	4.44 4.04	1.03 1.38	2.92	.004
59. Use language for thought	3.10 2.09	1.56 1.40	5.24	.001
61. Thoughts in words	3.12 1.97	1.56 1.35	5.96	.001
63. Hard to do two things	3.70 3.16	1.54 1.65	2.76	.006
65. Easy to translate thts	2.52 1.86	1.49 1.32	3.63	.001
66. Difficulty figuring now	4.29 3.54	1.19 1.51	4.74	.001
68. Verbal thinking	3.47 2.74	1.59 1.64	3.61	.001

* Lower score indicates more agreement with the item

** Items are shortened version. Complete items are listed by corresponding number in Appendix A.

TABLE 34

Age Differences on the Cognitive and Age Items - Items more True for Younger Subjects* (361 Younger and 77 Older Subjects)

	Items more True for Younger Subjects	Means Young/Old	S.D. Young/Old	t	p
6.	Reasoning gets better	1.37 / 2.27	.87 / 1.49	-.715	.001
7.	Talk through problems	1.60 / 2.01	1.19 / 1.58	-2.59	.010
16.	Use pics to remember	1.81 / 2.21	1.35 / 1.58	-2.29	.023
18.	Thoughts in images	2.03 / 2.64	1.42 / 1.71	-3.31	.001
21.	Trouble expressing	1.96 / 3.00	1.45 / 1.73	-5.52	.001
23.	Go off on tangents	2.96 / 3.45	1.62 / 1.70	-2.41	.016
26.	Remember new names	3.20 / 3.84	1.68 / 1.57	-3.09	.002
34.	Images of complex ideas	1.93 / 2.52	1.32 / 1.57	-3.41	.001
40.	Daydreams are vivid	2.42 / 3.30	1.59 / 1.71	-4.33	.001
42.	Solution using pictures	2.10 / 2.60	1.33 / 1.62	-2.85	.005
45.	Thinking in pictures	1.92 / 2.32	1.32 / 1.51	-2.37	.018
48.	Mind functions better	2.06 / 3.07	1.30 / 1.55	-5.98	.001
50.	Hard to connect words	3.39 / 3.95	1.57 / 1.42	-2.89	.004
52.	Talking expression good	2.70 / 3.29	1.64 / 1.58	-2.85	.005

Items more True for Younger Subjects	Means Young/Old	S.D. Young/Old	t	p
55. Visual images of thts	1.59 2.22	1.15 1.48	-4.13	.001
67. Visual thinking	2.41 3.29	1.58 1.62	-4.39	.001

* Lower score indicates more agreement with the item

which were more true for the older sample reflected more verbal thinking, enjoying verbal activities, or having difficulties with visual thinking.

Second, the 4 questions that made up the age scale were all significantly different for the two age groups. The younger sample responded more true to "My reasoning ability seems to get better as I get older" and "As I get older, my mind seems to function better than ever". In contrast, the older sample responded more true to "I do not remember things as well as I used to" and "I now have difficulty figuring things out which used to be easy for me. Age differences on the whole age-scale itself were examined. This scale is described on page 67. As expected, the older subject's scores were significantly higher ($\bar{X}$=13.00) than the younger group ($\bar{X}$=10.25), $t(436)=-6.79$, $p < .001$.

The factors for the two age groups were previously described. A summary of the factors with their communalities for the two age groups can be seen in Tables 35 and 36.

Age differences on two cognitive style measures, Richardson VVQ and SELFREP, were examined. Both were highly significant. On the VVQ, younger subjects were significantly more visual ($\bar{X}$=53.92) than older subjects ($\bar{X}$=47.65), t(436)=5.88, p <.001. On SELFREP, the self assessment of cognitive style, again, younger subjects were significantly more visual ($\bar{X}$=1.06) than older subjects ($\bar{X}$=-.55), t(436)=4.11, p <.001). The correlation between the two instruments (VVQ and SELFREP) was .42 (p .001)

TABLE 35

Summary of the Factors for the Younger Sample

		% of Variance Explained
1.	Thinking in Words	11.4
2.	Thinking in Picures or Images	9.4
3.	Trouble with Words	4.7
4.	Good with Words	3.9
5.	Can do Two Things at Once	3.2
6.	Strong Dreams	3.0
7.	Good Written Expression	2.7
8.	Reading Difficulties	2.5

TABLE 36

Summary of the Factors for the Older Sample

		% of Variance Explained
1.	Thoughts verbal, Good with Words	13.0
2.	Visual Thinking	10.4
3.	Word Person	6.5
4.	Strong Dreams	5.7
5.	Hard Time Expressing	4.7
6.	Two Things are Distracting	4.1
7.	Difficulties with Words	3.6
8.	Reading Difficulties	3.5

No other age differences could be examined. Because the older subjects were recruited from three different locations, and because older subjects of different ages (grouped in their 60's, 70's, and their 80's) were not equally represented from each location, various ages and locations would confound other analyses of these data.

Chapter IV

DISCUSSION

There were two primary goals in this dissertation. The first was to develop a clear way of operationalizing the concept of visual and verbal cognitive styles. The second was to show a relationship between these thinking styles and the effect of a cognitive intervention. In approaching these goals, one major and several minor hypotheses were tested and a new measure was developed.

The primary hypothesis is discussed in detail in order to explore why verbalization affected different people in opposite ways. The validity and the reliability of the instrument developed for this investigation will then be discussed, followed by a discussion of the secondary hypothesis, which include sex and age differences.

Attention will then be directed to the general applications of this study. Finally, some of the shortcomings of this investigation and suggestions for future research will be presented.

Primary Hypothesis: The Relationship between Verbalizing and Problem-solving

The primary hypothesis of this investigation predicted that the effects of verbalizing in a problem-solving situation would vary according to the cognitive style of an individual. While verbalization can potentially have

either a facilitative or a detrimental effect on an individual's problem-solving abilities, it was predicted that the problem-solving of individuals who were more verbal would be generally facilitated by verbalizing whereas the problem-solving of more visual individuals would be generally impaired by this intervention. Not only was this prediction confirmed, but it was strengthened by convergent evidence from three kinds of measures of cognitive style.

As expected, subjects revealed varying degrees of cognitive styles; they revealed different degrees of dominance of one kind of thinking. The results indicated that when more extreme data was examined, the results were more highly significant. In other words, when subjects who were strongly visual were compared to those who were strongly verbal (as evidenced by larger difference scores) these results were more significant than when subjects with smaller difference scores were compared. Of great importance, however, is that when all subjects were included in the analysis (using VOCABLOCK), the results were still significant. This suggests the generalizability of the findings.

In discussing the results of this hypothesis, the research that offers explanations for why problem-solving is affected by verbalization will first be considered. Comments from participants will be used to validate some of the ideas presented. Then, in an attempt to further

understand the meaning of the results, the findings will be discussed in detail.

Facilitative Role of Verbalization

The relationship between verbalization and problem solving has been investigated in many studies. These studies offer explanations for why verbalization can be an effective intervention. In discussing these explanations, the factors contributing to the facilitative effects are presented as being distinct; however, these factors almost always occur together. Thus, in any given situation, the exact nature of the facilitative effect remains a matter of conjecture.

One consequence of verbalization is an attentional effect that is the result of the process of describing things. It appears that in problem-solving situations, subjects often do not realize that a particular item could be used to solve a problem until it is verbally encoded (Daniel, 1972; Glucksberg and Weisberg, 1966; Jorg & Hormann, 1978). As Furth and Milgram (1973) stated, labeling focuses attention on the specific features of an item or situation and consequently helps to retain and recognize the material as a solid bit of data to be used. Similarly, Fuson (1979) claimed that the content of verbalizations directs attention to certain stimuli and away from others, and has an effect that is similar to the act of pointing (1979).

Another possible explanation for the positive effect

of verbalizing is that it helps encode relevant information into memory in a way that makes items and 'rules' more useful and available for retrieval (Birge, 1957; Datz, 1964; Furth and Milgram, 1973; Kobasigawa and Middleton, 1972; Loftus, Miller & Burns, 1978; Nelson, 1969; Rosse, 1964). In this manner, the effects of verbalizing have been attributed to increasing the potential for discovering important categories (Furth and Milgram, 1973), helping people discover general principles (Gagne & Smith, 1967), and helping to organize items that should be dealt with (Rohwer, 1973). These positive effects have been observed in many studies (Bartlett, 1980; Blank, 1974; Cohen, 1966; Craik & Watkins, 1973; Jorg & Hormann, 1978; Kendler, 1964; Ward and Legant, 1971; Bush & Cohen, 1970; Brooks, 1970; Dusek, 1978; Fuson, 1979; Hagen and Hale, 1973; Wheeler and Dusek, 1973).

Research has shown that cognitive mediators can act either independently or concomitantly. Perhaps the combination of visual and verbal encoding facilitates problem-solving by making the information much more available to memory than would be the case if only a single form of encoding were involved (Glucksberg and Weisberg, 1966). Subjects who verbalize have the advantage of remembering what they heard themselves say, in addition to remembering what they were thinking. Some of these suppositions are substantiated by the subjects:

I was uncomfortable talking at first, but I caught

mistakes by saying things out loud.

I hear myself say stuff. Then I know what I think. Hearing helps me remember things.

Talking pushed me. I don't know what I think until I write or say it. A lot of times I have to read questions out loud or I don't understand them.

Other researchers also attributed the facilitative effects of verbalizing to this increased mnemonic capacity (Atkinson and Shiffrin, 1968; Bartlett, 1980; Craik and Lockhart, 1972; Dusek, 1978; Hall & Halperin, 1972; Jorg & Hormann, 1978; Katz, 1964; Locke & Gehr, 1970; Moscovitch & Craik, 1976).

The facilitative effect of verbalization on problem-solving can also be attributed to 'time' factors. It has been suggested that the deliberate pacing of the task that accompanies the verbalizing conditions has some effects on performance (Bahrich & Boucher, 1968; Gagne and Smith, 1967; Ray, 1957). Fuson (1979) discovered that covert or overt use of verbalizations can prolong the amount of time a subject is willing to work on a task. With more time, verbalizing individuals could elicit more associations, and arrive at new relationships (Griffith, Spitz and Lipman, 1959).

It is possible that the act of verbalizing itself is responsible for the continuation of productive thinking; as discussed earlier, the Russian theorists proposed that the speech muscles actually guide the thought processes. Interestingly, several comments from the subjects seemed to substantiate this idea:

> I always talk in my mind. I move my lips to myself when I think. It helps me concentrate incredibly.
>
> Talking helped. Can't shut up my head. There's an internal dialogue. My brain is always saying something. If a good image comes it is because of that. I never see anything before I hear it. If I see something, I try to interpret it by talking.
>
> I think in words all the time. I always have to talk. I have a problem in a testing situation. I find it easier to talk out loud than think - even though I know it's the same. I can talk faster than I can think. It's like I'm always explaining something to someone.
>
> When I didn't talk I just stared at the pattern. I couldn't think. I think I would have done better if I talked.

Finally, there are some situational factors which could mediate problem solving performance by verbalization. First, subjects might try harder in the presence of the experimenter. The act of verbalizing in this setting might compel the subjects to examine the situation more closely (Ray, 1967). According to Gagne and Smith (1962), individuals were more likely to analyze problems in at attempt to find "good" reasons when they verbalized -- especially when someone was listening. Second, verbalization could be a means of self-communication, and may provide more incentive to explore unfamiliar data. If these notions are accurate, the subjects that were aided by verbalizing might have been previously unaware of the potential use of this process as a mediation tool.

The importance of these factors is reflected in comments from the subjects:

> Talking made me do better. I wouldn't have thought as much. I would have guessed on a lot more of them.
>
> Talking helped me get through the harder ones. When I didn't know what to think about.
>
> For the early ones it's harder to talk. I confused myself. It helped me on the harder ones. I hear my thoughts rather than just rambling on.

Detrimental Role of Verbalization

The detrimental effect of verbalization on problem solving was supported in this study both by comments from subjects and by results of the analyses. Similar results were found by other investigators (Jensen & Rohwer, 1965; Jorg & Hormann, 1978; Kendlers, 1961; Levin & Rohwer, 1968). Ranken (1963) found that language can either facilitate or inhibit performance on a task, depending primarily on whether the subject's verbalizations encoded relevant or irrelevant aspects of an experiment. Irrelevant information or misleading `rules' may stay in subjects' minds and inhibit further exploration (Levin & Rohwer, 1968). The labeling can prevent a closer examination of those features which are not relevant to the label verbalized (Ranken, 1963).

Subjects' verbalizations revealed both the tendency for relevant verbalizations to facilitate productive reasoning and for irrelevant or inaccurate verbalizations to inhibit performance. These verbalizations indicated that when confusion occurred, there was a tendency for subjects in the language condition to revert to the last

feature or pattern verbalized and to either a) continue from there or b) not attempt to go further and make a choice based upon the reasoning so far.

There are several explanations for the sometimes damaging effect of verbalizing. First, it constitutes an additional requirement. It is one more thing to do that requires attention, and thus can take attention away from the task. Second, the subject might feel intimidated or not know what to say. S/he could be adversely affected by the presence of the experimenter. Comments from subjects substantiate these notions:

> I feel dumb talking cause I'd be letting the tester know what I'm thinking.
>
> It's easier if I don't talk. It's an extra thing to do that's trying to enter your mind.
>
> I was thinking about what to say rather than the problems.
>
> I'd have rather not talked. I had a hard time concentrating. Normally I just use pictures. Thinking is too fast to talk.

Finally, verbalizing might interfere with the person's normal cognitive approach to problem solving, and may inhibit productive thinking.

Interference

In general, studies show that individuals working at full capacity will lose efficiency if required simultaneously to perform a second task (Broverman & Lazarus, 1958; Fitts & Posner, 1967; Postman & Underwood,

1973; Taylor, Kinsbourne & Cook, 1971; Taylor, Lindsay & Forbes, 1967; Welford, 1968). There is often competition for the processing resources required to perform certain activities (Norman & Bobrow, 1976; Welford, 1968).

Because verbal thinking is similar to the act of talking to oneself, the act of vocalization was not expected to interfere with verbal thinking in the present study. Rather, it was expected to facilitate this type of processing. Conversely, because visual thinking is dissimilar to the act of talking to oneself, the introduction of verbalization as an intervention was expected to create interference. In the present investigation, the fact that visual subjects performed better than verbal subjects without the intervention and not as well with the application of verbalization supports the notion that verbalization interferes with the cognitive processes of visualizers.

In addition to the empirical findings, many comments from subjects substantiate this interpretation:

> I do much better when I don't talk. It messed me all up. Those words are like someone else is talking to me. Shut up. Stop talking to me. Talking completely got in the way. I couldn't tell what I was thinking.
>
> Talking distracted me. I think just like that. To talk I have to translate it into words and then back so my mind can work on it again.
>
> Talking confused me. Seeing it is easier for me. When I write papers, it's never organized. Things never seem to go in order.

> I'd be thinking, and then I'd have to stop to say something, and then I'd get thrown off the track. I'd forget what I was saying, forget where I was and what I was thinking.

The concept of interference in relation to cognitive style is discussed in the literature. Galin and Ornstein (1974) suggested that processing in the inappropriate cognitive system may not only be inefficient, but it may actually interfere with processing in the appropriate system. Levy (1969) has suggested that verbal and nonverbal functions evolved in opposite hemispheres to reduce interference of one system with the other. Weisberg (1980) concluded that there are at least two relatively independent processing systems, a visual system and a verbal system. As he describes, "visual imagination requires the use of the visual processing system, and verbal imagination (as in subvocal speech) requires the use of the verbal system" (p. 159). According to Weisberg, the various interactions of these systems account for the selective interference by visual versus verbal tasks found by many researchers (Anderson & Bower, 1973; Atwood, 1971; Brooks, 1968; Bower, 1970b, DenHyer & Barrett, 1971; Postman & Underwood, 1973; Salthouse, 1975; Weisberb, 1980). These interactions are likely contributors to the results of the present study.

Mediation Effect as a Function of Problem Difficulty.

Some effects of interference and its complex relationship to cognitive style can be seen in visual and

verbal subjects' different reactions to verbalizing for tasks of varying levels of difficulty. The solutions to some of the easier problems were almost automatic, intuitive, and immediate for some visual subjects. Verbalizing on these problems was seen as particularly annoying by these subjects. The interference was indicated by the fact that visual subjects erred more on the easy problems than verbal subjects, and also by the visual subjects' comments concerning their reactions to verbalizing. However, verbalizing did seem to help many visual subjects when they were attempting the harder problems, probably for many of the same reasons that verbalizing helped verbal subjects.

In contrast, the verbal subjects found it much easier to verbalize while attempting the easier problems. Although the problems were relatively easy, verbal subjects did not see the pattern or know what to do with it until they began to talk. Subjects' comments reflect these differences:

> On the easier ones I didn't know what to say. As I went on, talking made it easier. It helped. Words helped me pick out the right ones. They messed me up on the easier ones though.
>
> For the early ones it was harder to talk. I confused myself. It helped me on the harder ones. I hear my thoughts rather than just rambling on.
>
> It was easy to talk on the earlier problems. It helped me find the patterns. But then it got harder. The designs were complicated and I wasnt sure what to say. With the simple pictures its easier to talk.

Manifestations of Visual and Verbal Styles

In this investigation, visual and verbal cognitive styles were manifested in subjects' test-taking behavior and comments. Three areas will be noted. These include: 1) subjects' comments about their thinking styles, 2) the nature of their definitions on the Vocabulary Test, and 3) types of verbalizations emitted by visual and verbal subjects. It should be noted that subjects were categorized here by their verbal self-assessments of their cognitive style rather than by any empirical data.

Subjects' comments about their thinking styles. Subjects comments about their own thinking offered insights into their personal experience of what was involved in visual or verbal thinking. Verbal thinking styles are reflected in the following comments:

> I do think in words. In strings of words, and that makes it an equation, like in geometry. If this and that, then the others. I think in words. I can see the words. I read and see words, not the image it represents. I can see it and hear it and have to do that first or the image is not there. I have to see words before I can express or apply an idea. I did the problems you just gave me by doing this.
>
> When no one's around, I talk out loud. I do better when I talk out loud. I'm explaining to myself. Even at lectures, I have to explain to myself or I get confused.
>
> I think completely in words. My verbal abilities are strong and I'm very comfortable with words. I'm more uncomfortable with visual things. I have difficulty figuring out math problems and imagining things. I never use images when I think.

Other subjects talked about their visual thinking styles.

Ideas are not in verbal form. The verbal is secondary. I can't put things into words. Thoughts would be too complicated. It's easier to picture it than say why I pictured it.

I can't explain things. Everything's in a picture. I have a problem explaining things I see. I can't read textbooks unless there's a picture. I have a hard time reading. Things are clear in my mind, but I can't explain it.

I put things in my mind and turn and twist it to see what I can do. Ideas have shapes in my mind. Neon sign flashes. Numbers. Waves. Days in boxes.

I have to picture it in my mind. If I can't picture it, I get blocked.

When I think or plan, I use pictures to see if it's possible. I don't really see relationships in words. I see them in pictures. It's a waste of time to translate.

I always see the picture. It's like a movie. I never talk to myself. It just comes up in my mind, especially for a test. A page comes in front of me. I read the question and the answer comes.

I see things by wholes, then parts. I see the whole, and then I can't explain the parts. I go around with things sitting in my mind as images. Just sitting there. Can't get it out on paper. I can't explain things so I feel satisfied. It frustrates me.

I think in pictures. Words produce right away pictures in my mind. What other way would there be? If I had no pictures, my brain wouldn't work. But words are only substitutes to pictures. Without pictures, you cannot think. Without pictures, what is it before your eyes? What is it before your eyes? It can be any book. (She picks up a book.) Naturally, like what is classical music? I have a picture of music before my eyes. I see in my mind baroque music with Handel standing there before my eyes. If you do not do this you can't have any understanding. How else do you understand what you read? I think there's no other way. People are restrained by words. You can't think about so much without pictures, even if you speak about emotions, you have to have a picture, in the expression of the face, and eyes.

Definitions. Visual and verbal cognitive styles were also manifested in the definitions given to the words on the Vocabulary Test. One striking difference was the tendency for many visual subjects to picture the objects and describe them. For example, a ship was described as "it's large, it goes on the water, it has smoke stacks with steam coming out, it has a crew on it." Similarly, a penny was described as "small, round, copper colored, you can buy gum with it, it has Lincoln on it." A sentence was defined as having "a period, lots of words, a beginning and an end." In contrast, verbal subjects often provided more abstract definitions, such as "a large vessel that sails on the water" or "one cent." Similar findings have been reported by others (Matarazzo, 1972; Webb & Haner, 1949). For example, Matarazzo reported as definitions of donkey, "an animal" and "it has four legs and it looks like a jackass". Although these other researchers have not specifically linked responses such as these to visual and verbal thinking styles, Matarazzo is aware that aspects of an individual's thought processes are reflected in the character of the definitions given (1972, p. 219).

Another interesting tendency was for visual subjects to 'act out' the word with their hands or their face, like 'slice,' 'perimeter', or 'ominous'. Interestingly, when asked for verbal clarification of the word, some of these subjects became so frustrated with their lack of ability to define the word that they wanted to give up.

Different Styles of Verbalizations. Although there were many variations in the content of each individual's verbalizations, some interesting patterns evolved regarding the differences in the verbalizations of visual and verbal individuals. Verbal subjects talked much more than visual subjects. In addition, the verbal subjects talked very specifically about the patterns and relationships in the problem at hand, and they seemed to verbalize their reasoning process. In contrast, visual subjects often spoke about the process of problem solving in general rather than the problems themselves.

The following comments are from verbal subjects attempting to solve a problem in Ravens Matrices.

> We have a single pinwheel, a single pinwheel going to the right, then they are going to the left, and then they are going together. The next line is similar. There is a fancier pinwheel at the bottom and it is going to the the right and then going to the left. So we have a fancier pinwheel, the fancy one with the double propeller - which we have in number seven.
>
> You have a flower in a circle and a flower in a square. You have a plus, a plus in a circle, so you need a plus in a square. Number five.
>
> Um, there are two different patterns going here. Outside, as you go down, it gets thicker, and as you go across, there's 3 different things. Oh, in the first row there's a spot, flower, and a plus. Here there's a flower, a plus and a spot. Here there's no flower in the last row. You need a flower with a thick thing around it, and you have it in number six.
>
> Let's see. When we go from a triangle to a square in the first column, a square to two circles. In both top and bottom, the top symbols match. So you would expect a cross on the top. And, I would

expect a circle underneath it. There would be a circle under the square, so the cross in a circle, would get number 1.

Here we have 3 crosses, 2 vertical lines, 3 horizontal lines, so you need a vertical line in a box with what kind of pattern? Two of those and 3 blanks so this would have to be it. Vertical line and a striped. So it's 1.

In contrast, the following comments are from more visual subjects. The first two examples were obtained from subjects attempting to solve the initial two problems presented above.

Um. That one's getting bizarro. Seven.

I would probably, oh no. Let's see. It's not, hm. There's a definite pattern for them. Oh I put number five because these are all normal. These are, I'll say number five.

Um. I'm trying to figure out patterns. How does it go? Well, it's not five. I wouldn't put the same thing next to each other. For some reason I want to put one in there. I think, and that's all connected, so it's got to be dots but not with squishy things around it. Maybe. So, two, I would say.

Wow. It's tough. Shoot. I like to try to look down here to see what it's going to look like. My mind draws a blank. I'll just say number three.

I'm not thinking anything yet. Okay. This one doesn't do that. It goes that way. So does this on. Hm, would be much more. Wouldn't be that. Huh. Okay. That's a point. Oh, wait a minute. Gosh, if they get harder than these I'm in trouble. That one can't be. I'll put 5.

The more general, less specific, and less instrumental speech of the visual subjects suggests they must be unfamiliar with verbalization as a problem-solving modality. Although they did verbalize as they were asked to do, they

did not use their verbalization to "talk themselves through the problem" or "guide themselves" as was suggested. This tendency further supports the notion that the process of verbalization runs counter to the normal approach of visual individuals. One explanation for this behavior is suggested by Paivio (1971).

Paivio discussed the tendency for adults to abandon mediational strategies they have been asked to use if those strategies are inappropriate. He further suggested that associative strategies are only partially controlled by experimental sets and that over trials, subjects increasingly revert to associative habits with which they are more familiar. In this investigation, the fact that the verbalizations of visual subjects continually revert to non-productive verbalizations, coupled with the fact that their level of performance drops when they verbalize, suggests that verbalizing is not effective as an intervention for them.

Although the protocols provide a rich source of data, they do not seem to provide equal access to the thinking processes of visual and verbal thinkers. Verbal thinkers seemed to verbalize their processes more fully. Their train of thought can usually be followed, as can their methods of discovery and analysis of the problems. For many visual subjects, the relationships between the thinking processes and their verbalizations were weak and vague. These differences raise an important question about the validity of theories of cognition that are based

primarily on analyses and categorizations of verbal protocols.

Suggestions of Pervasive Cognitive Styles. An instruction to verbalize seems to facilitate performance in those subjects for whom verbalization is an effective strategy. However, an instruction to verbalize hinders performance if the verbalization prevents the use of a more individually effective strategy. These patterns suggest that individuals might have consistent cognitive styles that strongly influence their normal approach to problems.

Paivio (1971) suggested that low imagers, regardless of their verbal prowess, prefer verbal thinking. It appears that subjects lacking visual skills tend to rely upon more verbal means of cognitive functioning -- or would strongly benefit by doing so. Similarly, it is probably true that those with verbal difficulties would tend to rely on more visual strategies. This hypothesis is partially substantiated by the reactions to verbalization of those subjects who have more "trouble with words" (Factor #3) as compared to those who do not. The former reacted in the same manner as visual subjects; that is, performance decreased with verbalization. Similarly, those subjects for whom words were not a problem reacted like verbal subjects. This suggests that individuals with weaknesses in one particular area tend to rely on the other style as a predominant mode.

This tendency suggests additional applications for results of this study. For individuals with spatial problems (for example, older individuals, or individuals with right-hemisphere damage), there is a fairly good chance that verbalizing would facilitate problem-solving and other kinds of behaviors as well. For individuals with verbal difficulties however, further research is required to determine whether the development of training procedures would yield an improvement in performance with verbalization. If the assumption that these individuals either rely on, or would benefit from spatial thinking is correct, and if verbalizing cannot serve a facilitative function, then the application of other appropriate facilitative techniques (see Edwards, 1979, Perecman, 1983) is warranted.

Development of a Measure

Another major goal of this dissertation research was to create a method for measuring visual and verbal cognitive styles. To this end, a new instrument was developed: a 68 item questionnaire which was factor analyzed in order to derive visual and verbal factors. The validity and reliability of this new measure will now be discussed.

Validity

This measure seems to have successfully tapped into visual and verbal dimensions of thinking. In both the younger and older groups, the first two factors were "verbal thinking" and "visual thinking." This does support the face validity of the measure.

Paivio and Harshman (1983) performed a factor analysis of a related measure (Paivio's IDQ) and used a comparable sample. Both the similarities and the differences between these factor analyses suggest additional support for the validity of the measure used in this investigation. A summary of the factors from each is shown in Table 37.

TABLE 37

Comparison of Factors in Paivio's Factor Analysis to those in the Present Study (Younger Sample)

Paivio's Factors
1 - Good verbal expression and fluency
2 - Habitual use of imagery
3 - Concern with correct use of words
4 - Self-reported reading difficulties
5 - Use of images to solve problems
6 - Vividness of dreams, daydreams, and imagination
Factors from the Present Investigation
1 - Verbal thinking
2 - Visual thinking
3 - Trouble with words
4 - Good with words
5 - Can do 2 things at once
6 - Strong dreams
7 - Good written expression
8 - Reading difficulties

What is missing in Paivio's questionnaire is a factor reflecting verbal thinking. Therefore, Factor 1 ("verbal thinking" contains mostly new items and few from Paivio's IDQ. Paivio's verbal factors focused on verbal skills and attitudes ("good verbal expression and fluency" and "concern with correct use of words"). The present study generated two factors concerned with verbal skills ("trouble with words" and "good with words"), but identified in addition, "verbal thinking" as a separate factor. Paivio and Harshman's factor analysis produced two visual factors ("habitual use of imagery" and "use of images to solve problems"). This study, in contrast, produced one strong "visual thinking" factor which combined the elements of Paivio's two visual factors. Most of the strong items in Paivio's "habitual use of imagery" and "use of images to solve problems") were included in Factor 2 ("visual thinking") in the present investigation. Paivio's work produced two other factors: "self reported reading difficulties", and "vividness of dreams, daydreams, and imagination". This study produced essentially those same two factors.

Although the present questionnaire and Paivio's shared only 23 questions, the factor analyses resulted in the generation of very similar factors. The similarity of the factors suggests that these factors represent important cognitive dimensions in the college populations. This is especially significant given the fact that less than one

third of the questions were the same.

Another criterion for the validity of the instrument was the test of whether the cognitive dimensions reflected by the factors could predict reactions to the intervention. Although the results using this measure were variable, in general, this was the case.

Reliability

Unfortunately, test-retest data were not available for the new instrument. Therefore, to obtain some estimate of the reliability of the instrument, two methods were used to examine the internal consistency of the factors obtained from the factor analysis. Both these methods used data from the younger sample only. The first method was the computation of Cronbach's alpha coefficient. Overall, these results suggested that the factors were only moderately reliable. Factor 1, "verbal thinking", was more reliable than Factor 2, "visual thinking".

The second method of examining the internal consistency of the factors involved a split-sample factor analysis on the younger sample. It should be noted however, that the two sub-samples each had approximately 180 subjects. This is considerably less than is suggested for a factor analysis of 64 items. Although examination of the differences suggests low reliability, further testing with larger samples might reveal more reliable data. Since the older sample had even fewer subjects, and the factor structure for the older sample had factors in common with

each of the younger sub-samples, it is possible that much larger samples from both age groups would reveal more similar factors for older and younger groups.

How much of the moderate reliability is a result of the relatively small sample size and how much is a result of a weak measure needs to be determined by further research. Most likely, both factors contribute. Further development and refinement of the questionnaire is warranted and should lead to a more reliable instrument.

Secondary Hypotheses: Group differences

Sex Differences

Only a few sex differences were found in the present investigation. The most significant was a difference on the second factor, "visual thinking". This difference is consistent with literature on sex differences which reports greater spatial and visual aptitudes for males. However, the lack of sex differences on other measures suggest that the differences are minor.

There were no sex differences on most of the analyses testing the main hypothesis. Only one analysis revealed a main effect for sex. In this analysis (using SELFREP), males had higher scores on Ravens. Because, as revealed in Table 1, males were slightly higher on all measures, this main effect is not unexpected. The fact that other analyses didn't reveal this same difference suggests that this difference is probably minor. There is no way of

determining from the present data whether males participated in the experimental portion for different reasons than females, or whether the males in the college population generally have slightly higher scores on cognitive tests.

There were sex differences on a number of items from the questionnaire. However, differences on these items do not reflect any particular trends.

Age Differences

Two subject populations were included in this study: elderly subjects over 60 and undergraduate college students. As discussed earlier, age differences in this investigation were potentially confounded by ethnicity, religious orientation, educational background, and differences in sampling procedures. Therefore, the few age differences that were obtained cannot necessarily be attributed to the effects of aging. Still, they could be age-related, and will be considered.

The primary dependent measure used in this investigation was Ravens Progressive Matrices. Because instructions for the test called for different versions for older and younger subjects, the samples could not be compared on this measure. The only dimensions that could be statistically compared were the responses to the individual items, the age-scale, Richardson's VVQ and SELFREP, the measure based on each subject's assessment of his or her own cognitive style.

Essentially, most findings reflected the tendency for older subjects to be less visual and more verbal in their styles and their self assessments. This was reflected in differences in Richardson's VVQ, in SELFREP, and in many of the items in which old and young differed. These findings are consistent with the many age-related studies on memory, visual 'intelligence' and mediation strategies which tend to suggest that aging individuals are less visual when they are older (Cattell, 1972; Gordon & Slevin, 1975; Horn, 1976a, 1976b, Horn & Cattell, 1967; Hulicka & Grossman, 1967 Hulicka et al., 1967; Nebes, 1976; Rowe & Schnore, 1971; Wilkie & Eisdorfer, 1974).

Because actual age-related changes cannot be differentiated from the other potentially confounding variables, there is no illumination of the etiology of the differences in visual or verbal orientation. Still, these differences suggest important implications for the findings of the present investigation. These will be discussed later in this section.

The data suggest that although older subjects were affected by the act of verbalizing in the predicted manner, the effects were not significant. Therefore, another difference between the old and young was the lack of significant findings for the main hypothesis for older subjects. While it is possible that young subjects are more affected by the intervention than older subjects, a more likely explanation for the lack of significance for

older subjects is the extremely small sample size. There were only 44 older subjects in the experimental groups, and therefore, very few in each group.

The final difference between the old and young sample was a strong difference on the age-scale. This suggests either the diminishing of cognitive abilities with age, or a lack of confidence on the part of the older subjects in their abilities to remember, to reason and to think clearly. Since there is a vast amount of research substantiating both the decline in abilities and a lack of confidence (Birkhill & Schaie, 1975; Hartley, Harker & Walsh, 1980; Hoyer & Baltes, 1974; Hoyer & Plude, 1980; Labouvie-Vief, Willis & Baltes, 1980), this result is not unexpected.

Further Implications of the Findings

Applications for the Elderly

This study suggests that the less visual individuals are and the poorer they do in a problem-solving situation, the more they are aided by verbalizing. This finding has important applications for helping the elderly who, as previously discussed, become less visual as they get older.

It is assumed that the small sample size significantly contributed to the lack of significant results for the elderly. Several other kinds of research suggest the usefulness of intervention research for aging individuals. For example, investigations have found that the cognitive

deficits commonly found in the elderly in problem-solving situations can be partially alleviated with very brief, short-term intervention techniques (Denney, 1979). Potential improvement in performance on cognitive tasks for older individuals is becoming more evident as more evidence is accumulated on the modifiability of performance via intervention research (Baltes & Schaie, 1976, p. 724). Another finding especially common in research with older subjects is the tendency of such individuals not to use problem-solving strategies which they are capable of using (Jerome, 1962; Meichenbaum, 1974). The spontaneous utilization of these strategies seems to decay (Jerome, 1962). For example, while young subjects often spontaneously employ both verbal phrases and mental images to enhance their retention of stimulus material, the elderly rarely use such mnemonic devices (Hulicka & Grossman, 1967; Hulicka, Sterns, & Grossman, 1967; Rowe & Schnore, 1971). Similarly, other studies found that elderly subjects who are poor problem solvers fail to spontaneously use mediation devices (e.g. strategies, mnemonic aids, self-instructions) unless these devices are suggested to them (Arenberg, 1965, 1967; Canestrari, 1963; Crovitz, 1966; Meichenbaum, 1974; Welford, 1958).

All of these factors, combined with the tendency for older people to be more verbal and less spatial, suggest that the findings of the present investigation can have special significance and applications for these older individuals. Thus, deficits in performance by older

people are not caused necessarily by a loss of intelligence, but often because such individuals do not use available strategies effectively. Although this can be true of subjects of any age, older persons have particular problems which make the intervention especially appealing. Older subjects often spontaneously generate numerous negative self-instructional statements which interfere with task performance (Labouvie-Vief & Gonda, 1976). Second, the performance deficit reported in so many studies, in combination with the tendencies of older individuals to lose spatial abilities and not use heuristic devices spontaneously, creates a special need for improvement and intervention.

Research on the relationship between spatial abilities and utilization of services and neighborhoods suggests an additional application for the findings of this study. The learning and remembering of spatial information is crucial to individuals who travel outside their homes to benefit from goods and services, to engage in employment, or to seek entertainment. It is necessary to know the destination and combinations of paths, and to remember the locations of significant landmarks at which changes in direction must occur (Walsh, Krauss, and Regnier, 1981). Studies indicate that older individuals with poorer spatial ability did not know their neighborhoods as well as did those who had greater spatial ability (Stafford & Krauss, 1980). They were less able to navigate their environment,

and consequently, went out less often, had a more restricted range of travel (Walsh, Krauss, & Regnier, 1981) had less knowledge of neighborhood goods and took less advantage of services that were specifically designed to help them (Krauss, Awad, Ohta & Regnier, 1980).

These individuals could be trained either to verbalize or (if their verbalizations weren't productive), to verbalize in a particular manner. Such training could greatly improve the relationship of the elderly to their environment.

Intervention research

Investigations into cognitive manipulation have attempted to introduce various intervention strategies and techniques into the problem-solving situation. The assumption underlying most of these studies has been that it would be "desirable to try to change individuals' problem-solving performances if techniques capable of effecting such change could be found" (Denney, 1979, p. 59). The importance of this type of investigation has been increasingly acknowledged, especially with regard to elderly individuals (Baltes & Labouvie, 1973; Baltes & Schaie, 1976).

However, several shortcomings have been consistent in intervention research. Researchers concentrate primarily on the success or failure of a particular intervention, and frequently fail to make other important distinctions. In general, individual differences are not examined with a

view toward determining whether particular interventions are better for different individuals or types of individuals. The pervading assumption in psychological research seems to be that different levels of performance owe to quantitative differences between people. That individuals differ qualitatively, and therefore respond differently to manipulations is rarely considered. The psychological community would benefit from educational research which considers the fact that individuals differ in qualitative or stylistic ways and thus benefit from different interventions and different approaches to learning.

As a primary example of this shortcoming, one can consider verbalization, which is one technique used in research as a cognitive intervention. Studies on the use of verbalization as a cognitive mediator have presented varied, weak, and inconclusive results and inconsistent conclusions (Flaherty, 1975; Hafner, 1957; Roth, 1965): a) verbalizing yields considerably greater computational error which, in turn, destroys the potential benefit (Flaherty, 1975) or, b) instructions to verbalize can prevent interference if instructions are bland enough so they do not direct a subject to produce specific kinds of information (Simon, 1979).

As this study demonstrated, effects of verbalization can be obscured by combining the results from individuals with different cognitive styles. This possibility is

ignored in intervention research. The present investigafound that verbalizing helps some subjects and hurts others. If verbalizing and nonverbalizing subjects were compared without attending to the cognitive styles, the differences were entirely eliminated. In this investigation, the mean score on Ravens for those (younger subjects) verbalizing was 17.93 and for those not verbalizing, it was 18.60. Neglecting consideration of cognitive factors would have obscured the findings.

Much has been learned about how individuals use language in problem solving, especially from the research of Meichenbaum and his associates (1971a, 1971b, 1972, 1973, 1978). In analyzing the verbalizations of children, they found that some subjects did not habitually and spontaneously analyze their experience in verbal terms and did not formulate and internalize rules that might guide them in new learning situations. Other children use their speech in a more mature, more instrumental, and more self-guiding fashion (Meichenbaum, 1967, 1972). Meichenbaum did not investigate many cognitive differences between subjects. Only the tendency to be reflective or impulsive was examined. Of significance, however, is that Meichenbaum then trained people to use language differently, and by doing so, changed their behavior in desired directions. While training subjects, he gave them fairly strict guidelines as they progressed through the cognitive stages necessary to arrive at the desired behavior or correct solution. Interestingly, he found that

many of the desired behaviors could be demonstrated six months following the experiment. Unfortunately, Meichenbaum failed to investigate the possibility that subjects were unaware, prior to the experiment, that language could be used to mediate behavior, and that this awareness in itself was sufficient to produce modified problem solving behavior. However, he did discuss the potential effectiveness of verbalization, and the potential trainability of those who do not use their speech in productive ways.

Meichenbaum's research, coupled with the results of the present study, suggest some additional applications of intervention. This study suggests that, for those who are verbal, or those who are naturally "connected to" words and verbal thought, the suggestion to verbalize in a problem-solving or other difficult situation could enhance their performance and possibly enrich their experience. If verbalizers realized that their performance would be facilitated by verbalizing, they could use this technique covertly whenever they needed to think through a problem. For those who are visual, or non-verbal, the present study indicated that the suggestion to verbalize could have a detrimental effect. However, Meichenbaum's research indicated a potential trainability of those individuals who do not use speech in a very productive way. Perhaps visual subjects could be helped to use verbalization. The data (described on page 150) indicated that at least some visual

persons were helped by verbalizing on more difficult problems. In sum it seems that by understanding a person's cognitive style, and then either training them or helping them to understand the value of verbalizing, this technique has the potential for being a very useful tool in various learning situations.

Visual and Verbal Cognitive Styles

There are several issues concerning the conceptualization of cognitive style that will be discussed. First, the results of this investigation substantiate the notion that individuals do have visual and verbal cognitive styles. The results suggest that people are aware of, or at least they can estimate the visual or verbal nature of their cognitive style, and they can describe concomitant preferences, habits, attitudes, and aptitudes. The results also suggest that these styles are strongly related to particular abilities, and that they can therefore be measured by performance on certain tasks, or by performance on several tasks.

Second, the data corroborate the notion that cognitive styles are value-neutral and that they differ from abilities. They are value neutral because they are not, by themselves, positively related to high performance (on Ravens). Rather, performance depends on how individuals' cognitive styles interact with the intervention. In addition, the results indicate that neither cognitive style

is better than the other, but rather, they are advantageous in different situations.

Third, this research has important implications. Briefly, if cognitive factors can help determine or explain the usefulness of an intervention, then these cognitive factors can potentially explain many other important behaviors and differences between people. If individuals learn that they have a particular "thinking style", then they can learn more about their strengths and weaknesses, enabling themselves to make more appropriate decisions in short term problem-solving situations and for long term planning. They might come to an understanding that some of their weaknesses may be task specific and might learn ways of improving their areas of weaknesses keyed to the task at hand. Other practical applications include adaptation of educational materials or activities for those with strong visual or verbal preferences. Once a cognitive style is recognized and there are clear ways of measuring it, further research can be directed toward understanding its antecedents and etiology, its development, and its role in learning. The determination of why an individual has a certain style, the manner in which personal styles can be expanded and changed, and developmental issues concerning how and why these styles change with age also present opportunities for further research.

Suggested for Improvements and for Future Research

The method used in this investigation for discerning visual and verbal cognitive styles offers a promising avenue for further investigation. However, there are many ways this research and the instrument itself could be improved.

Some students complained about the difficulties they had in responding to items which could be either true or false in different situations. Unfortunately, any true-false test that contains cognitive items probably would suffer the same problems. Cognition involves complex processes, and it is difficult to answer specific questions about the workings of these processes. It is especially difficult to assess one's own thinking in the short amount of time usually available for test-taking. Some students commented that they had never thought about their thinking before and that they were not sure about their answers. Some also commented that they were afraid they had been inconsistent. Although time restrictions create difficulties, perhaps a small paragraph explaining the emphasis of each item would be useful.

The measure could be revised to produce stronger, less ambiguous items. Items that loaded poorly on the factors should be eliminated, and other new items should be added. One way of developing a stronger measure of visual or verbal style might be to discuss these thinking styles with strongly visual and verbal individuals, and to create new items based on their personal experiences and the meaning

of the concepts to these individuals.

It would be valuable to offer a battery of visual and verbal tests, with revised versions of this questionnaire to a very large number of subjects of different ages. Rotation figures, mechanical tests, and various analogies tests should illuminate cognitive abilities that are related to visual and verbal thinking. In addition, categorizing individual styles of problem solving and relating them to cognitive style would offer further insights into the cognitive processes involved. It would also strengthen the results if all subjects were in both verbalizing and non-verbalizing conditions on tasks. Recording the amount of time required by different subjects to solve the problems might also provide important information.

Some of the analyses suggest that the Block Design was not as good a visual test as the Vocabulary Test was a verbal test. The Block Design predicted responses to Ravens for those not verbalizing, as evidenced in the multiple correlations. When combined with the Vocabulary Test scores to form VOCABLOCK, it provided the strongest confirmation of the major hypothesis. However, by itself it was not significantly related to most other cognitive style measures, and it was not significantly related to the "visual thinking" factor. Judging from the high scores on the Block Design test, the relatively low scores on the Vocabulary Test, and the distribution of the factor scores,

this sample was much more visual than verbal. Perhaps the high visual orientation of the sample provided a comparatively restricted range, making correlations and discriminations more difficult. It is possible that the Block Design was contaminated by general intelligence more than other tests would be. Perhaps a test like the Picture Completion (from the WAIS), or another more visual test would reflect a more pure visual ability.

Most of the responses to the demographic questions were too vague and varied to use in the analyses. Future research should improve both the items and the format so that personal and demographic variables can be examined to see how they are related to cognitive dimensions.

The need for future research suggested by this study is great. Despite the lack of results for the older subjects involved in this investigation, many questions were raised that concern potential age-related changes in cognition. It is still unclear whether aging individuals actually lose spatial abilities, whether there are cohort differences which explain the changes, or whether older people just stop using strategies that are available to them (Baltes & Labouvie, 1978; Baltes & Schaie, 1976; Giambra & Arenberg, 1980; Huyck & Hoyer, 1980; Willis & Baltes, 1980). Data on individuals' cognitive styles could illuminate this research. It is possible that differences in cognitive style make individuals more vulnerable to aging deficits; perhaps those individuals with particular styles are differentially affected by the process of aging.

It would be interesting and valuable to have a large enough sample (of varied ages) to be able to compare old and young subjects on factor scores and see what differences are obtained in their cognitive styles. First, comparable age samples would have to be carefully selected. It would also be valuable to give old and young subjects the same version of Ravens or a similar test and determine whether one age group is actually more affected by verbalizing.

The verbalizations that occurred during the problem-solving process suggest potential avenues for research. It would be interesting to categorize subjects' verbalizations and relate the patterns to other aspects of the individuals' cognitive performances. It might be valuable to compare these classifications to styles of doing the Block Design and the Vocabulary Test.

Conclusions

This investigation has illuminated several areas of research. First, it has shed light on the importance of qualitative approaches to intervention research. Specifically, this study confirmed the hypothesis that there are cognitive factors that partially determine the effectiveness of an intervention for an individual. These cognitive factors, as well as other important personal and cognitive variables should be considered before recommending particular interventions for individuals.

Care should be taken to assess more accurately the effects of manipulations. Attention to possible confounding variables would contribute to research results being more appropriately interpreted and applied. Otherwise, potential interactions as well as important findings and benefits may be obscured.

This investigation highlighted the potential value of verbalization as a heuristic device for people with compatible cognitive styles. This process can be taught to people in educational settings, and to those individuals who experience difficulties in problem solving.

This investigation has illuminated the functional significance of visual and verbal thinking and has provided a method for discerning these styles. Further exploration of the methods and of these styles should have practical applications in educational and gerontological settings, as well as implications for advancing educational and psychological research. The results of this investigation strongly indicate the importance and potential value of continued research on visual and verbal cognitive styles.

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APPENDIX A

This appendix has a list of all the items on the questionnaire used in this study. Items are either from Richardson's VVQ, or Paivio's IDQ (which includes all of Richardson's items), or they were newly created for this study. For those newly created, they were either cognitive items or age-related.

Paivio's: P
Richardson's: R

Created for this study: S
Cognitive: C
Age related: A

Item	Source or Type
1. When I talk to somewone on the phone, I often have a visual image of the person I am talking to.	S C
2. Sometimes I close my eyes to help me concentrate.	S C
3. I cannot listen to two things at the same time.	S C
4. My powers of imagination are higher than average	R & P
5. I don't believe that anyone can think in terms of mental pictures.	R & P
6. My reasoning ability seems to get better as I get older.	S A
7. When trying to understand a problem, I find myself "talking" my way through the problem (either silently or aloud).	S C
8. I would find it difficult to write an outline before I write something.	S C
9. I am good at remembering the details of what I read.	S C
10. I often use mental pictures to solve problems.	P
11. It is sometimes difficult for me to remember names of things.	S C
12. I find it difficult to assemble something just be following a diagram.	S C

13.	I retain the main ideas of what I hear or what I read, but I rarely remember the words used.	S C
14.	Most of my thoughts are verbal in nature.	S C
15.	My daydreams are rather indistinct and hazy.	R & P
16.	I often use mental images or pictures to help me remember things.	P
17.	My approach to understanding tends to be more logical than intuitive.	S C
18.	Thoughts are often represented in my head in the form of images and pictures.	S C
19.	I enjoy doing work that requires the use of words.	R & P
20.	When thinking or talking to myself, I find that I don't use words for ideas and objects that I can visualize.	S C
21.	I sometimes have ideas that I have trouble expressing in words.	P
22.	I consider myself to be a "word" or "verbal" person.	S C
23.	When I talk, I tend to go off on tangents.	S C
24.	Images of people and things do not just pop up in my head. They are filled in from verbal or written descriptions.	S C
25.	I spend very little time attempting to increase my vocabulary.	R & P
26.	I am usually good at remembering new people's names.	S C
27.	I seldom dream.	R & P
28.	I arrive at conclusions before I can explain why.	S C
29.	I have better than average fluency in using words.	R & P
30.	When I read, I sometimes have to read passages over several times to understand what I am reading.	S C

31.	I prefer to learn from written descriptions more than from graphs and diagrams.	S C
32.	My dreams are extremely vivid.	R & P
33.	I cannot generate a mental picture of a friend's face when I close my eyes.	R & P
34.	I get visual images while I read, even of complex ideas.	S C
35.	I do not remember things as well as I used to.	S A
36.	Even when someone is talking about something I am interested in, I find myself easily distracted.	S C
37.	I seem to be very aware of detail in my surroundings.	S C
38.	My thoughts and ideas tend to be so intertwined that I often don't know what order to present the ideas in when I speak.	S C
39.	I read a great deal.	P
40.	My day dreams are sometimes so vivid I feel as though I actually experience the scene.	R & P
41.	I find it easy to do other things while I watch television.	S C
42.	By using mental pictures of the elements a problem, I am often able to arrive at a solution.	P
43.	I can easily express myself in writing.	S C
44.	I enjoy learning new words.	R & P
45.	My thinking often consists of mental pictures or images.	R & P
46.	I can express myself more clearly when I write than when I talk.	S C
47.	When "talking to myself," I often imagine talking to another person or to an audience.	S C
48.	As I get older, my mind seems to function better than ever.	S A
49.	I can "turn off" noise or chatter in my environment so it does not bother or distract me.	S C

50. When I talk or write, it is hard for me to words that express the connection between ideas.	S	C
51. I can easily picture moving objects in my mind.	P	
52. I can express myself more easily when I talk than I can when I write.	S	C
53. I can easily think of synonyms for words.	R & P	
54. I do not form a mental picture of people or places when reading of them.	P	
55. When I am along with my thoughts, I find that I usually have visual images of what I am thinking about.	S	C
56. I can usually explain how I got from the beginning of a problem to the final solution or conclusion.	S	C
57. I am able to express my thoughts clearly.	P	
58. Words are needed for conversation with others. Privately, I do not need to rely on words for thinking.	S	C
59. When thinking, I use language and words much more than I use visual images.	S	C
60. I have a strong nonverbal sense of things.	S	C
61. Thoughts are represested in my head in the form of words.	S	C
62. I prefer to read instructions about how to do something, rather than have someone show me.	R & P	
63. It is difficult for me to do more than one thing at a time.	S	C
64. I read rather slowly.	R & P	
65. My thoughts are easily translated into words.	S	C
66. I now have difficulty figuring things out which used to be easy for me.	S	A
67. My thinking is more "visual" than "verbal".	S	C
68. My thinking is more "verbal" than "visual".	S	C

APPENDIX B -- COMPLETE QUESTIONNAIRE

UNIVERSITY OF CALIFORNIA, SAN FRANCISCO
CONSENT TO BE A RESEARCH SUBJECT

Sherry Spitzer is a graduate student in Human Development and Aging who is interested in learning about different cognitive styles, or more simply, about different ways of thinking.

To explore this topic, a questionnaire containing many kinds of questions will be given to men and women of all ages. The questionnaire will take less than 20 minutes to fill out. For those who would like to participate further and learn more about their particular thinking styles, additional educational tests will be given. It should be noted that while the study focuses on how people think, the focus is not on individual acheivement or levels of performance, and thus, there will be no pressure of any kind to perform well.

Participation is completely voluntary, and all information obtained will be kept completely confidential. There are many things that could be learned by anyone who participates, and the only disadvantage of participating is the possible nuisance of giving up a little time.

I have received a copy of this form. I have the right to refuse to participate or to withdraw at any time. If I have any further questions, I can reach Sherry at (415) 665-4368 (in San Francisco) or at (213) 780-3194 in Los Angeles.

_____ _____

Date Participant's Signature

Name _____

Age _____ Sex _____

Phone Number _____

THIS IS FOR RESEARCH PURPOSES ONLY.
ALL INFORMATION WILL BE KEPT COMPLETELY CONFIDENTIAL.

What is/was your occupation? _____

If you are not working now but plan to in the future, what is your occupational goal? _____

What was your highest level of education? Circle the appropriate answer.

a) elementary school b) high school c) some college

d) finished 4-year degree e) graduate school f) trade school

g) other _____

What was your major field or interest? _____

What is your religious background? _____

What is the predominant ethnic or national origin of your ancestors? _____

_____

Do you have any major problems hearing? _____

Do you have any major problems seeing? _____

What are your hobbies or interests? _____

_____

Would you be interested in participating in future research? _____

May I phone you later on to get your reactions to this questionnaire? _____

INSTRUCTIONS

The statements of the following pages concern ways of thinking, studying, and problem solving which are true for some people and not for others. Read each statement and decide to what extent it is true or false for you. Then indicate your answer by putting an "X" in the appropriate column next to the item.

There are 5 choices for each statement:

TRUE	MORE TRUE THAN FALSE	NEITHER TRUE NOR FALSE	MORE FALSE THAN TRUE	FALSE

Whenever you can, put an "X" in either the TRUE or FALSE column. Keep in mind that because these statements are very general, probably very few will be absolutely true or false all of the time or in all situations. So, if the statement is true for you often or in most situations, or if the statement is true for you a lot more than it is false, put an "X" in the TRUE column. And if the statement is false for you often or in most situations, or if the statement is false for you a lot more than it is true, put an "X" in the FALSE column.

It is very important to answer every question. If neither the TRUE nor the FALSE column seems right, put an "X" in either the MORE TRUE THAN FALSE column or the MORE FALSE THAN TRUE column, whichever is more appropriate. Please try very hard to avoid the middle column - NEITHER TRUE NOR FALSE. Reserve this only for questions which do not in any way apply to you. Try to fit each answer into one of the true or false columns.

Answer the statements as carefully and honestly as you can. The statements are NOT designed to judge the goodness or badness of the way you think. They are attempts to discover the methods of thinking you consistently use in various situations. There are no right or wrong answers.

Please answer every statement even if you are not completely sure of your answer.

	TRUE	MORE TRUE THAN FALSE	NEITHER TRUE NOR FALSE	MORE FALSE THAN TRUE	FALSE
1. When I talk to someone on the phone, I often have a visual image of the person I am talking to.					
2. Sometimes I close my eyes to help me concentrate.					
3. I cannot listen to two things at the same time.					
4. My powers of imagination are higher than average.					
5. I don't believe that anyone can think in terms of mental pictures.					
6. My reasoning ability seems to get better as I get older.					
7. When trying to understand a problem, I find myself "talking" my way through the problem (either silently or aloud).					
8. I would find it difficult to write an outline before I write something.					
9. I am good at remembering the details of what I read.					
10. I often use mental pictures to solve problems.					
11. It is sometimes difficult for me to remember names of things.					
12. I find it difficult to assemble something just by following a diagram.					
13. I retain the main ideas of what I hear or what I read, but I rarely remember the words used.					
14. Most of my thoughts are verbal in nature.					
15. My daydreams are rather indistinct and hazy.					
16. I often use mental images or pictures to help me remember things.					
17. My approach to understanding tends to be more logical than intuitive.					
18. Thoughts are often represented in my head in the form of images and pictures.					
19. I enjoy doing work that requires the use of words.					

	TRUE	MORE TRUE THAN FALSE	NEITHER TRUE NOR FALSE	MORE FALSE THAN TRUE	FALSE
20. When thinking or talking to myself, I find that I don't use words for ideas and objects that I can visualize.					
21. I sometimes have ideas that I have trouble expressing in words.					
22. I consider myself to be a "word" or "verbal" person.					
23. When I talk, I tend to go off on tangents.					
24. Images of people and things do not just pop up in my head. They are filled in from verbal or written descriptions.					
25. I spend very little time attempting to increase my vocabulary.					
26. I am usually good at remembering new people's names.					
27. I seldom dream.					
28. I arrive at conclusions before I can explain why.					
29. I have better than average fluency in using words.					
30. When I read, I sometimes have to read passages over several times to understand what I am reading.					
31. I prefer to learn from written descriptions more than from graphs and diagrams.					
32. My dreams are extremely vivid.					
33. I cannot generate a mental picture of a friend's face when I close my eyes.					
34. I get visual images while I read, even of complex or abstract ideas.					
35. I do not remember things as well as I used to.					
36. Even when someone is talking about something I am interested in, I find myself easily distracted.					

	TRUE	MORE TRUE THAN FALSE	NEITHER TRUE NOR FALSE	MORE FALSE THAN TRUE	FALSE
37. I seem to be very aware of detail in my surroundings.					
38. My thoughts and ideas tend to be so intertwined that I often don't know what order to present the ideas in when I speak.					
39. I read a great deal.					
40. My day dreams are sometimes so vivid I feel as though I actually experience the scene.					
41. I find it easy to do other things while I watch television.					
42. By using mental pictures of the elements of a problem, I am often able to arrive at a solution.					
43. I can easily express myself in writing.					
44. I enjoy learning new words.					
45. My thinking often consists of mental pictures or images.					
46. I can express myself more clearly when I write than I can when I talk.					
47. When "talking to myself," I often imagine talking to another person or to an audience.					
48. As I get older, my mind seems to function better than ever.					
49. I can "turn off" noise or chatter in my environment so it does not bother or distract me.					
50. When I talk or write, it is hard for me to find words that express the connection between ideas.					
51. I can easily picture moving objects in my mind.					
52. I can express myself more easily when I talk than I can when I write.					
53. I can easily think of synonyms for words.					
54. I do not form a mental picture of people or places when reading of them.					

	TRUE	MORE TRUE THAN FALSE	NEITHER TRUE NOR FALSE	MORE FALSE THAN TRUE	FALSE
55. When I am alone with my thoughts, I find that I usually have visual images of what I am thinking about.					
56. I can usually explain how I got from the beginning of a problem to the final solution or conclusion.					
57. I am able to express my thoughts clearly.					
58. Words are needed for conversation with others. Privately, I do not need to rely on words for thinking.					
59. When thinking, I use language and words much more than I use visual images.					
60. I have a strong nonverbal sense of things.					
61. Thoughts are represented in my head in the form of words.					
62. I prefer to read instructions about how to do something, rather than have someone show me.					
63. It is difficult for me to do more than one thing at a time.					
64. I read rather slowly.					
65. My thoughts are easily translated into words.					
66. I now have difficulty figuring things out which used to be easy for me.					
67. My thinking is more "visual" than "verbal".					
68. My thinking is more "verbal" than "visual".					

Would you be interested in talking further about this research? _____

Any comments now? _____

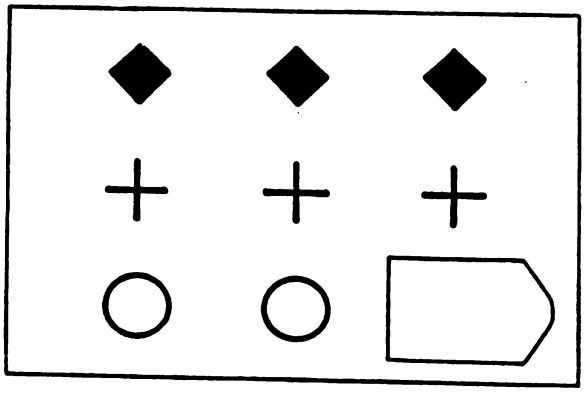
_____

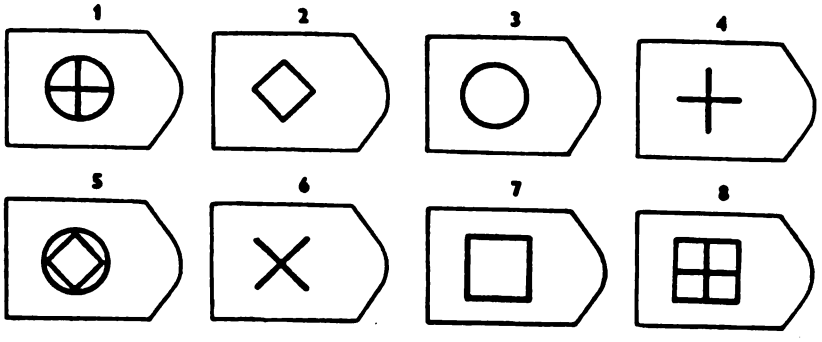
_____

APPENDIX C

These 2 examples of Raven's Matrices are the 2 easiest ones given to the younger sample.

D-1





D-2