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The Effects of Age, Sex, and Verbal Mediation on the Digit Symbol Test

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THE EFFECTS OF AGE, SEX, AND VERBAL MEDIATION ON THE DIGIT SYMBOL TEST

by

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LIFE

Jerome S. Pietrzak was born on January 27, 1943 in Chicago, Illinois. After graduating from St. Ailbe Grammar School in 1957, and then from Mount Carmel High School in 1961, he attended De Paul University until June of 1965, when he was awarded a degree of Bachelor of Arts in psychology. Following one trimester of full-time graduate study in psychology at the University of Florida, he gained his first clinical experience at Chicago State Hospital as a Mental Health Rehabilitation Intern. In September of 1966, he began full-time graduate work in clinical psychology at Loyola University. He completed a clerkship and an internship at the Loyola Guidance Center and another internship at the Veterans Administration Hospital in Hines, Illinois. In February of 1970, he obtained his Master of Arts degree in clinical psychology at Loyola University. While continuing his work toward the doctorate degree in clinical psychology at Loyola University, he was a part-time instructor of psychology at Loyola from September 1970 to June 1971. He has twice been the recipient of U.S. Public Health Fellowships, in the academic years of 1968-69 and 1970-71. Currently, the author is employed as a clinical psychologist at the Lake County Mental Health Center in Waukegan, Illinois.

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TABLE OF CONTENTS

LIST OF TABLES

Table		Page
28.	Frequency Distribution of Ss Responding "Yes," "Uncertain," or "No" to a Question Concerning Their Awareness of the Need for Speed in Their DSy Performance	210
29.	Supplementary Analysis of Variance Summary for the DSy Scores of the Old Age Sample	212
30.	Supplementary Analysis of Variance Summary for the DSy Scores of the Young Adult Sample	213
31.	DSy Means, n's, and t values for the Supplementary Analysis of the Secondary Hypotheses Using Only the Spontaneous Mediation, Young Adult Subsample	219

LIST OF FIGURES

CHAPTER I

Introduction

In periodically reviewing the massive literature on the Wechsler intelligence scales since 1945, Guertin and his colleagues (Guertin, Frank, & Rabin, 1956; Guertin, Ladd, Frank, Rabin, & Hiester, 1966; Guertin, Rabin, Frank, & Ladd, 1962; Rabin, 1945; Rabin & Guertin, 1951) have often drawn pessimistic conclusions regarding the analysis of Wechsler subtest patterns for diagnostic purposes. The inadequacy of diagnostic categories and the unreliability of subtests are frequently cited as sources of variance that contribute to the unsuitability of using subtest patterns for individual diagnosis. A potentially more profitable approach would be to derive hypotheses from individual subtest scores and to seek confirmation or modification of them by checking them against one another until an integrated description of the person emerges. This would ordinarily be the approach of the clinician studying the individual case.

What this approach requires, however, is a well researched body of knowledge of what each subtest measures. In their recent review of the Wechsler scales, Guertin and his colleagues (Guertin, et al., 1966, p. 395) decried the lack of research on this problem:

> Too few studies were conducted to test the psychological rationale proposed for the individual subtests.... Much more work would seem to be needed to assess the validity of the assumptions underlying performance on the subtests, upon which interpretation of performance is based.

The general aim of this present research, therefore, is to make an intensive study of one Wechsler subtest and thereby clarify and extend its psychological significance. For several reasons, the Digit Symbol (DSy) Subtest of the Wechsler Adult Intelligence Scale (WAIS) has been chosen for this purpose:

1. As Murstein and Leipold (1961) have noted, much less is known about the DSy Test than any other WAIS subtest. This is apparent upon surveying the research literature and is reflected in the relative lack of attention given to DSy in major discussions of the Wechsler scales (e.g. Allison, Blatt, & Zimet, 1967; Patterson, 1946; Rapaport, Gill, & Schafer, 1945; Wechsler, 1958).

2. DSy appears to be factor analytically unique among the WAIS scales in its large amount of task specific and uninterpreted variance. This raises the question of what it is that DSy measures that the other subtests do not measure. Commenting upon DSy's factorial specificity and Digit Span's low correlations with the other verbal subtests, Guertin, et al. (1966) have recently questioned whether the deletion of these subtests from the WAIS battery would result in any appreciable loss of information regarding general intelligence or cognitive

functioning. Although Digit Span has received considerable research attention (Frank, 1964), there is no comparable data available with which to evaluate the importance of DSy in the WAIS battery.

3. The DSy Test is an unusually rapid and moderately valid measure of general intelligence (Wechsler, 1958).

4. Numerous significant but unexplained relationships have been hypothesized between DSy and age, education, sex, personality traits, examiner (E) variables, motivational states, and conditions of behavioral inefficiency such as emotional disturbance, organicity, vagrancy, and underachievement. These will be elaborated in Chapter II.

It is hoped that the value of this dissertation will be threefold: (a) The review of the literature was meant to be extremely extensive, to summarize all that is presently known about the DSy Test, and to provide the starting point for an extended program of research. (b) As a first step in conducting this program of research, this dissertation experiment focuses on the effects of age, sex, and verbal mediation on the DSy Test. In the context of this research, verbal mediation refers to the use of descriptive, verbal labels for visually perceived symbols. In performing the DSy task, the subject (S) may have recourse to subvocal verbal mediation in conceptualizing the symbols involved in the DSy pairings. That is, he may give some or all of the symbols individual descriptive names which supplement or supplant a purely visual memory or discrimination of the symbols. It is the effect of this verbal mediation upon performance on the DSy subtest of the WAIS which is the main subject of the present research. At the conclusion of Chapter II, specific hypotheses are made concerning age and sex as well as verbal mediation. Verbal mediation will be hypothesized to interact with age and sex in ways which help to explain previous findings regarding the effectsof age and sex on the DSy Test. (c) In addition to the experimental study of verbal mediation, preliminary data will be collected in order to explore other DSy hypotheses. Primarily, these hypotheses will concern alternative explanations for the DSy sex difference in favor of females.

For the reader who is not familiar with the DSy Test, the standardized instructions to the DSy Test as it appears in the WAIS are provided in Appendix I along with the symbols and their associated digits. Although the following review of the literature includes references on several forms of the DSy Test, it is the WAIS DSy Test and its Wechsler-Bellevue predecessors which have been researched the most, and which, therefore, receive the most emphasis here.

CHAPTER II

Review of the Literature

Learning Ability

In the words of David Wechsler (Wechsler, 1958, p. 81), "The Digit Symbol or Substitution test is one of the oldest and best established of all psychological tests." Long before Wechsler constructed his intelligence scales (Wechsler, 1939, 1946, 1949, 1955, 1967) and included a DSy or coding type of task in each one of them, Thorndike (Thorndike, 1926) had noted that DSy was the only test of learning ability to be used as a measure of intelligence. According to Wechsler's description of the test (Wechsler, 1955, p. 81), the "subject is required to associate certain symbols with certain other symbols, and the speed and accuracy with which he does it serves as a measure of his intellectual ability." The assumption that DSy measures new learning of the associative type received its first really substantive challenge in 1950 when Burik compared DSy's validity as a measure of new learning to its validity as a measure of motor speed and coordination.

Using the Wechsler-Bellevue DSy Test, he (Burik, 1950) administered Form I of the test to 50 female high school students, interviewed them, administered standard tapping, dotting, digit cancellation, and associate learning tests, and retested the Ss on Form II of the DSy Test, this time with special instructions to learn the DSy associations. The standard instructions do not specifically direct the S to learn the associations, and he is therefore free to interpret his task as either requiring that he learn the symbols or requiring simply that he fill them in as he is directed to do. Of Burik's Ss, only 16% employed the former approach of consciously attempting to learn the associations on the DSy I Test.

Recall for the DSy associations was found to be positively but insignificantly correlated with DSy performance (the number of symbols correctly filled in) on both Form I and Form II. Performance on the associate learning task similarly failed to correlate significantly with DSy performance. Thus, DSy performance was significantly related to neither the associative learning of the DSy pairs nor to an independent measure of associative learning ability. On the other hand, the WB DSy I scores were significantly ($p < .01$) related to each one of the motor tests. When Ss were explicitly told to learn the DSy associations (DSy II), the correlations between DSy and associate learning scores tended to increase, while the correlations between DSy and the motor tests tended to decrease. Although the correlations between DSy and associate learning still did not reach statistical significance, the explicit directions to learn the associations reduced the correlations between DSy and the motor tests, leaving only the tapping task significantly related to DSy ($p < .05$). Burik concluded that even when directions to learn the associations are added, the learning process involved is so minor that it is overshadowed by the primary significance of the motor factor. Nevertheless, a mean of 7.1 DSy associations were recalled from DSy I and 6.8 from DSy II, indicating that associative learning did occur, even if it was unrelated to DSy performance.

Note that the number of DSy associations learned was not increased by explicit directions to learn them, even though only 16% of the Ss had consciously attempted to learn the associations previous to these directions. It would seem that the incidental learning on DSy I had been at least as effective as the intentional learning on the equivalent DSy II. An alternative and more plausible explanation is that fatigue interfered with performance on the DSy II Test, which was preceded by DSy I, dotting, tapping, digit cancelling, paired associate learning, and other experimental procedures. Therefore, Burik's investigation still left open the possibility that an insertion of explicit directions to learn the DSy associations could make DSy a test of associative learning. Certain of Burik's observations make this possibility seem somewhat unlikely, however. For example, 88% of his Ss felt that the attempt to learn the symbols slowed up their performance. He observed that attempts to learn the symbols resulted in inefficient performance characterized by delayed reactions, hesitancy, and obvious perplexity with particular symbols.

Luchins and Luchins (1953) observed that the standard administration of the DSy Test involves ambiguous instructions that produce a conflict situation for the S, who may vacillate between attempts to learn the code or DSy associations on the one hand, and straight forward copying of the symbols on the other hand. They designed their experiment so as to compare the effects of several different variations in the DSy instructions, thus clarifying some uncertainties left unexplored by Burik (1950). Using a group administration, Luchins and Luchins employed four different sets of instructions: one analagous to Wechsler's standard instructions, one which made the directions to learn the associations explicit, one which explicitly stated that it was unnecessary to learn the associations, and one which made the learning of the associations the primary task, indicating that the number of items actually completed was unimportant.

Subjects in phase one of the experiment were administered the WB DSy Test under these four different conditions, and then were tested for the amount of learning they had accomplished. Two types of tests were employed for this purpose. First, the Ss were given a code test which presented them with a list of the digits (the code key without the symbols), and required them to fill in the matching symbols within 30 seconds. Second, they were retested on the DSy task, but this time without any code key provided. In phase two of the experiment, other Ss were tested in the same manner, but were given special "speed" instructions. This consisted in making the Ss acutely aware of the time element, and periodically harrassing them with unrealistic feedback concerning the supposed slowness of their performance relative to that of most college students.

The results of the experiment failed to support the assumption that DSy measures new learning of the associative type. DSy scores were not predictive of DSy learning as measured by the code test and retest. Furthermore, the highest DSy scores were achieved by the Ss who were instructed that it was unnecessary to learn the symbols. This was true whether or not the Ss also were given "speed" instructions. Apparently, attempts to learn the symbols impair the S's efficiency, causing him to spend less time and concentrated effort on performing the coding task itself. The results also corroborated the position held by the authors that the ambiguity of the DSy instructions leads to vacillation in the method of approaching the task and results in lowered performance. In the first phase of the experiment, the instructions not to learn the code produced significantly better performance than the standard instructions ($p < .02$). In the "speed" phase of the experiment, the standard instructions elicited consistently inferior performance compared to each of the three experimental instructions ($p < .01$).

Concerning the effect of the "speed" instructions, it was found that they increased the performance level of the "learn only" group ($p < .02$), while showing an insignificant tendency to decrease the performance level of the Ss receiving the standard instructions. The former finding is phenomenologically ambiguous in that Ss in the "learn only" group were told on the one hand that the number of items completed was unimportant, and on the other hand, the slowness of their performance was implicitly criticized as inferior. Inasmuch as the disruptions and harrassments of the so called "speed" condition really constituted a stress condition, this experiment does not really shed light on the question of how speed orienting instructions affect DSy performance. A more subtle encouragement of speedy performance might have facilitated performance under the standard instructions rather than inhibiting it. As we shall see in discussing E effects on the DSy Test, extremely subtle E cues may effectively constitute "speed" instructions that could facilitate performance for many Ss.

Although Burik's (1950) findings received support in this research by Luchins and Luchins (1953), Murstein and Leipold (1961) found fault with Burik's methodology and proposed another test of the associative learning assumption. They recognized the fatigue effect of Burik's long series of experimental tasks, complained of his failure to take account of the rate of learning as well as the final learning score, and noted the "ceiling effect" caused by the limited number of DSy items in the standard forms. Accordingly, they used a shorter series of experimental tasks, and counterbalanced their order of presentation; they employed a motor task that was more similar to the motor component of the DSy Test and a learning task that was more similar to the hypothesized learning component of the DSy Test; and they employed five trials as the learning criteria instead of just one composite score. Rather than lengthening the DSy Test in order to alleviate the "ceiling effect" as their criticism suggested that they might do, they apparently retained the standard form of the WB DSy II, adapted for group administration. The motor task that they employed involved reproducing symbols from 100 different slides, and the learning task involved slide presentation of 12 letter-symbol pairs. All tasks were group administered, and the <u>S</u>s were 192 male and female elementary and high school students.

All of their experimental refinements notwithstanding, Murstein and Leipold (1961) obtained essentially the same results an Burik (1950). DSy performance was significantly ($p < .01$) related to motor ability but unrelated to learning ability. DSy was also unrelated to a crude measure of intelligence: achievement-age equivalency scores divided by chronological age.

While the evidence favoring a motor interpretation and rejecting a learning interpretation of DSy is convincing (Burik, 1950; Luchins & Luchins, 1953; Murstein & Leipold, 1961), there is more evidence to consider. Willoughby (1929, 1930) assumed that the learning which occurred on DSy tasks was incidental rather than intentional, and yet his own data indicated that for 300 Ss ranging in age from 6 to 68, DSy scores correlated .369 (PE = .033) with the number of DSy associations recalled. Apparently, DSy performance was at least minimally related to DSy learning. However, Willoughby's research was conducted under admittedly unfavorable conditions. The DSy task was administered to family groups in the homes of the Ss, where cheating and other departures from the instructions occurred and were "allowed for" whenever they were observed.

Using typing achievement as a criterion of motor learning ability, Luotto (1963) partialed out the variance due to intelligence as measured by the Doppelt short form of the WAIS, and found that the WAIS DSy, administered before the Ss began their typing course, correlated significantly with subsequent typing speed (r = .55, $p < .01$) and accuracy (r = .38, $p < .05$), measured at the end of the course. The higher correlation of DSy with typing speed than with typing accuracy undoubtedly reflects the larger amount of DSy variance accounted for by speed as opposed to accuracy. Inasmuch as errors seldom occur on DSy in a normal population, it is perhaps surprising that DSy correlated even as high as .38 with typing accuracy. More surprising yet was the finding that for the sample of 40 female commercial high school students, DSy correlated negatively with the short form I.Q. scores ($r = -.33$, $p < .05$). No explanation was suggested for this latter finding.

Luotto's results are difficult to reconcile with the previous literature which so overwhelmingly rejected a learning interpretation of DSy (Burik, 1950; Luchins & Luchins, 1953; Murstein & Leipold, 1961). However, careful analysis of the criterion measures employed in the previous research reveals a potentially significant difference between Luotto's criterion task and the criteria employed by the others. Burik (1950), it will be remembered, used a recall test and an independent verbal associate learning test as measures of associative learning. Neither of these tasks require the kind of visual search used to locate the DSy pair in a code key, as is performed by most _S_s engaged in the DSy Test. This "location finding" process involves a different type of learning than that tested for in the previous research. Rather than learning the DSy associations abstractly, the _S_ can simply learn to look quickly in the right place in the code key for the symbols that need to be filled in with their corresponding digits. The most efficient and high scoring Ss are those who use this latter approach (Burik, 1950; Luchins & Luchins, 1953). Yet, the tests of learning used in previous research were not constructed to permit this type of learning. Instead, the S typically was required to recall the symbols from memory when presented with the digits. A more adequate test of learning which would not have eliminated this "location finding," visual-motor factor would have been a simple retest, exactly duplicating the original test. In this way, improvements in the DSy score would have reflected whatever types of learning occurred, including visual-motor practice effects which must be considered valid components of learning.

Thus, the criterion measures of learning that were employed in the studies which rejected DSy as a measure of learning ability all differed importantly from the original DSy learning situation. In Luotto's experiment, however, the criterion measures —typing speed and accuracy—involved this same "location finding" process which is apparently involved in the DSy task. In the act of typing, of course, the skillful S may not search visually for the correct key, but he learns, in effect, to search motorically for it. Whereas the S in the DSy task obtains sensory feedback visually as well as motorically, the S in the typing task primarily obtains his feedback through kinesthetic cues, and secondarily through visual cues as he sees what he has typed.

In conclusion, it appears that while DSy performance may not very well predict verbal learning of the associative type, it may measure certain relatively specific, visual-motor forms of learning. Inasmuch as the positive aspect of this conclusion is based primarily on one experiment (Luotto, 1963), further research is obviously needed to substantiate it. It must be acknowledged that even in Luotto's (1963) experiment, DSy accounted for only a very small amount of the variance in the criterion tasks employed—approximately 30% for typing speed and 14% for typing accuracy. On the other hand, some authors (Luchins & Luchins, 1953; Rapaport, Gill, & Schafer, 1945) have described other forms of learning and styles of performing the DSy task which have never been fully researched. It may be too soon to make any final conclusions regarding DSy and learning ability.

In editing his important book on adult intelligence for a fourth and most recent edition, Wechsler (1958) was faced with the results obtained by Burik (1950) and Luchins and Luchins (1953). The study by Murstein and Leipold (1961) and that by Luotto (1963) had not yet appeared in the literature. Wechsler (1958, p. 81) acknowledged that the "one concern that presents itself in the use of the Digit Symbol Test for measuring adult intelligence is the possible role which visual acuity, motor co-ordination, and speed may play in the performance of the task." He noted further that the role of motor speed in particular cannot be discounted.

Wechsler apparently was faced with a dilemma. The rationale for the inclusion of DSy in the Wechsler intelligence scales was apparently based on its alleged ability to measure new learning of the associative type. The research of Burik (1950) and Luchins and Luchins (1953) already appeared to seriously challenge that rationale. Wechsler's (1958) response to this situation was to assert, en effect, that if DSy measures motor speed and motor speed is shown to be a valid measure of current intellectual ability, then DSy is a valid test of intelligence. Specifically, Wechsler based his argument on the results obtained from elderly _S_s on his intelligence scales. Wechsler (1958, p. 81) noted that "scores on the test begin to decline earlier and to drop off more rapidly with age than other tests of intelligence. At the same time, however, the test's correlation with Full Scale scores at different ages remains consistently high." If there is any change at all in the correlation of DSy and general intelligence with increasing age, it is clear from the normative data (Wechsler, 1955, 1958) that it increases with age. As Wechsler concluded, the deficit that elderly people obtain in DSy appears to be warranted by the fact that they not only are slower in motor performance, but are "slowed up" in their general intellectual functioning. According to Wechsler (1958, p. 81), the "question that remains is whether speed as well as power should be given weight in the evaluation of intelligence." Wechsler has concluded that it should (Wechsler, 1958).

Intelligence

Whether or not DSy is a good measure of learning ability, the fact remains that it is a relatively valid and efficient measure of intelligence, thus giving empirical justification for Wechsler's decision to include some form of it in each of his scales. The standardization data of the WAIS is illustrative of DSy's validity (Wechsler, 1958). Its correlations with WAIS full scale score for various age groups ranged from .63 for the 25 to 34 year olds to .74 for the 60 to 64 year olds. DSy's correlation with full scale score was among the lowest in the battery for young and middle aged Ss, but among the highest for older Ss. With level of education, it correlated at a higher level than any other performance subtest for all age groups examined, ages 18 through 54. For 18 and 19 year olds, DSy's correlation with education (.609) surpassed that for all subtests except Information (.658) and Vocabulary (.624), two tests heavily weighted with school relevant, verbal factors. Thus, while DSy's concurrent validity as a measure of intelligence is respectable but mediocre, its predictive validity in reflecting level of education is quite superior. The relationship between educational advancement and intelligence is well established (Wechsler, 1958), so that DSy seems to be a good predictor of intellectual achievement. Considering the speed with which it is administered and scored, DSy is not only a reasonably valid measure of intelligence, but a very practical, efficient one.

What can account for DSy's validity as a measure of intelligence when it seems to be more a measure of motor speed than learning ability? Wechsler's position seems to be that speed of intellectual functioning is a valid measure of one's current intellectual effectiveness. As an argument for retaining DSy in a battery of intelligence tests, however, it is not enough to show that DSy measures speed. We must ask, speed of what? If DSy measures speed of intellectual functioning, what type of intellectual function is involved if it is not new learning of the associative type as formerly thought? If no other intellective process can be linked to DSy performance, it can still be retained in the WAIS battery on the empirical grounds that "it works" as a measure of intelligence. That is, it contributes to the validity of the WAIS as an intelligence test. However, if little of DSy's variance is due to intellective factors, it might be more consistent to regard the DSy Test as a nonintellective measure of intelligence or a measure of the nonintellective aspects of intelligence. Wechsler (1940, 1950, 1958) has repeatedly argued that nonintellective factors such as temperment, personality, and motivation play an important role in intellectual functioning, and therefore should not be eliminated altogether from tests of intelligence.

At this point, however, the more basic question remains: what intellective process, if any, is involved to any considerable extent in the DSy Test? More generally, what else, if anything, besides motor speed and some limited form of learning is measured by DSy? To answer this broad question, two approaches seem especially useful in uncovering other variables of potential significance in DSy performance: phenomenological analysis and factor analysis. That is, the DSy task can be analyzed first from the standpoint of the S performing the task, and then from the standpoint of the psychometrist studying the variance that DSy has in common with other subtests of the Wechsler scales, especially the WAIS.

Phenomenology of DSy

The S's experience with the DSy Test begins, of course, with the instructions given to him by the E. In the administration of the DSy subtest of the WAIS, the E places the DSy record form containing the code key and test sheet before the S, and delivers the following instructions (Wechsler, 1955, p. 44):

> Look at these boxes. Notice that each has a number in the upper part and a mark in the lower part. Every number has a different mark. Now look here (pointing to samples) where the upper boxes have numbers but the squares beneath have no marks. You are to put in each of these squares the mark that should go there, like this (point to key then to samples). Here is a 2, so you would put in this mark. Here is a 1, so you put in this mark. Here is a 3, so you put in this mark.

Writing in these first three sample items as a demonstration, the E then provides the S with a pencil and has him complete the seven remaining items of the sample. If the S has difficulty during the practice phase, he is given assistance until the sample items are completed. Pointing to the first square of the test proper, the E says to the S:

> Now when I tell you to begin, start here and fill in as many squares as you can without skipping any. Ready, begin.

The S is given 90 seconds before he is told to stop, and his score is simply the number of correct responses completed within the time limit. Half credit is given for reversed symbols, although this error seldom occurs on the WAIS form of the test. The Wechsler-Bellevue DSy Test, the predecessor of the WAIS, had included a "reversed N" as one of the symbols, resulting in the frequent error of producing the letter N. The symbols or "marks" and their respective digits are shown in Appendix I, as they would appear in the WAIS code key.

In the DSy Test, the S's first task is to decide, on the basis of the instructions and the demonstration, what he is supposed to do, or what is demanded of him. He is told that he must fill in as many squares as he can, but he is not told how much time he will have in order to do this. In fact, he is given no explicit indication that he will have a limited amount of time. Many Ss deduce the existence of a time limit from the implicit speed instructions and from observation of the E's stop watch, but an unknown number of Ss may not be alert enough to understand this aspect of the test and may perform more poorly because of this. It would be interesting to know and easy to determine, for example, how many Ss are completely taken by surprise when, after 90 seconds, they suddenly are told to stop working. It may rightly be concluded, however, that Ss who do not deduce the existence of a time limit, or worse yet, do not understand the necessity of working quickly, are those with very low intellectual ability. If this were true, then the resulting decrement in DSy score would correctly reflect the S's real intellectual level and would contribute to the test's validity.

If the S is aware of the necessity of working quickly, he is working "under pressure." He is engaged literally in a "race against time" in his effort to fill all of the squares with the appropriate symbols. In this sense, the speed aspect of the test constitutes a psychological stress, eliciting those stress reactions most characteristic of each S. One component of any stress reaction is the degree of anxiety that the S experiences, so that anxiety could be an important variable in DSy performance. Another variable of possible significance in relation to the speed requirements of the DSy Test is the S's affective state or mood at the time of testing, be it hopeless depression at one extreme or manic euphoria at the other. A related variable is the S's "energy level," which along with other motivational variables determines how hard the S can work if he tries, and to what extent he actually does try to do well. DSy performance involves sustained effort, and hard work, both mental and physical. Thus, according to Allison, Blatt, and Zimet (1967, p. 31), DSy measures "the amount of energy output a subject can generally bring to his work and his activities." These variables will be considered in more depth at a later point in the review of the literature.

Determining how quickly he should work may ordinarily be a very easy decision for the S to make, but it is not the only one he faces implicitly as he begins his task on the DSy Test. The instructions also allow a wide range of possible strategies which the S can employ, and he must begin to use one of them, even though he has only seconds in which to explicitly consider the possible ways of approaching the task. This situation is what Luchins and Luchins (1953) described as a conflict situation for the S, who may vacillate between explicit attempts to learn the DSy associations on the one hand, and straight forward copying on the other hand. Actually, these two strategies are not the S's only alternatives. Rapaport, et al. (1945, p. 289) described these and other strategies as forms of learning that may occur on the WB DSy:

> The learning process...may be of three kinds. First, it may imply, "What symbol goes with this digit?" Second, it may be of a more spatial-motor type and imply, "Whereabouts on the sample line is the digit whose symbol I must look up, and whereabouts in the line of empty squares do I have to return to go on

> working?"...very efficient people will refrain from any effort to remember which symbol goes with which digit, and rather organize well for an efficient copying-job by learning merely the spatial position of the material to be copied. A very efficient variation of this method, involving considerable concentration, consists of not falling back systematically upon the samples, but rather using the nearest identical copied symbol as a sample. The third kind of learning is present in both of the first two, and has only a slight learning character; it involves the efficient writing of the nine symbols which are, in great part, habituated anyway.

While emphasizing the role of the visual-motor channel of learning, Rapaport and his associates (1945, p. 289) noted:

> The verbal-motor function may also become the channel of a type of learning seen when the patient mutters to himself while working.

This latter style of DSy performance involves a verbalization of the symbol, vocally or subvocally. By naming each of the symbols, the S can then use the verbal-motor channel instead of, or in addition to, the visual-motor channel. Some of the Ss tested by Luchins and Luchins, (1953, p. 137) used this strategy with the WB form of the DSy Test:

> Thus, some called the symbol for 1 a dash or hyphen, the symbol for 2 an inverted N, the symbol for 3 an inverted C, the symbol for 4 the letter L, the symbol for 5 the letter U, the symbol for 6 the letter O, the symbol for 7 an inverted V, the symbol for 8 the letter X, and the symbol for 9 an equal sign....

A similar technique used by some of their Ss was to relate the shape of the symbol to the shape of its corresponding digit. For example (Luchins & Luchins, 1953, p.. 137):

> There were...subjects who...regarded the symbol for 1 as a 1 which was rotated, the symbol for 2 as

essentially a 2 lying on its side, the symbol for 3 as corresponding in shape to the form of each part of this digit, the symbol for 4 as the upper part of this digit, the symbol for 5 as the bottom part of this digit lying on its side, the symbol for 6 as the bottom circle of this digit, the symbol for 7 as this digit viewed from a different angle, the symbol for 8 as a pair of crossed straight lines structurally similar to the crossed curves which compose the 8.

There is one other readily apparent strategy that the S might employ, but it is expressly forbidden by the instructions, and the E reminds the S of this restriction if he violates it. This strategy would be to work on only one type of symbol at a time, filling in the symbol each time its digit occurs, while skipping all other digits, and then moving on to the next DSy pair, so on through the series of DSy pairs. The restriction that prohibits this strategy is that the S must fill in each successive square without skipping any.

With the exception of this approach, the S may use any of the various strategies or any plausible combination of them. Since there is little time for the S to consider the possible approaches to the test before he is told to begin, it would be expected that most Ss would begin simply by copying the symbols, with no explicit strategy in mind. Although the instructions do not explicitly demand any specific strategy, the demonstration provided by the E tends to encourage this kind of mechanical copying process. In that demonstration, the E refers to the digit in the sample test, points to the corresponding DSy pair in the code key, and then fills in the appropriate symbol after referring back to the sample test. Note that in the demonstration, the E does not stop to memorize the code key; instead he simply demonstrates the copying procedure, item by item. Not only do many Ss start off by using this straight forward copying technique, but many apparently use it throughout (Burik, 1950). Many other Ss start off in this manner, and then attempt to explicitly learn the DSy associations, often only to realize that they do not have enough time to use their learning to advantage. Thus, the S may then switch back to a mechanical copying procedure or vacillate between these two approaches (Luchins & Luchins, 1953), in which case he loses considerable working time and performs rather inefficiently.

It has been noted (Walker, personal communication, 1970) that many very intelligent Ss, particularly females, apparently study the code key intently for a time, and then fill in the squares very quickly with no, or only a few, glances back at the DSy code key. Ss using this technique sometimes fill in every one of the 90 items correctly, with time to spare. However, most Ss cannot learn the associations quickly enough to achieve a high score within the short time limit, so that an explicit attempt to learn the associations is usually a very unproductive approach (Burik, 1950; Luchins & Luchins, 1953). The usual inefficiency in explicitly learning the associations is apparently due to the brevity of the test, and is compounded if the S does not anticipate the rigid 90 second time limit. If he assumes that his score will be determined by the over-all length of time required to fill in all of the items, rather than the number of items correctly filled in within 90 seconds, he may take more time to learn the associations. That is, he may anticipate making up for the time spent in learning once he begins filling in the symbols form memory.

A final ambiguity in the DSy instructions is one that the S may never consciously consider. Nevertheless, it may influence his performance and it does involve an implicit choice of performance style. The scoring of the DSy Test is very lenient regarding qualitative aspects of performance in that the symbols need not be drawn very carefully or neatly, as long as the essential shape is retained. If a S takes extra time to produce the symbols exactly, he works more slowly and earns a lower score. Thus, Gurvitz (1951, p. 18) has noted that DSy "offers a bonus to impulsiveness and slapdash attack while penalizing the slow or careful worker." While this aspect of performance is undoubtedly related to the personality of the S, it may also come under more explicit cognitive control if the S specifically wonders how haphazardly he can draw the symbols without losing credit. The instructions are ambiguous in this regard, except for the demonstration and sample items through which the E may model and reinforce either an impulsive or a careful performance style. Thus, if the E demonstrates a haphazard scribbling of the symbols, the attentive and intelligent S may conclude that his use of the same style is permissable. If the E's style is more deliberate and careful, then the S has no indication that a less exact reproduction of the symbols is adequate and even advantageous. Similarly, if the S is not admonished from drawing his symbols in an impulsive fashion on the sample items, he may rightly conclude that he may continue in this style for the test itself. In fact, an unusually thoughtful S might purposely use the sample items to test the limits of acceptable performance. A very careful drawing of the sample items should also elicit no comment from the E, but in this case, the S has obtained no useful information.

In summary, it can be seen that the instructions to the DSy Test involve several ambiguities which confront the S with implicit choices and alternate strategies in performing the task. It seems likely that some of these strategies are more productive than others and consequently lead to higher DSy scores. To the extent that the selection itself of the most efficient strategies and response styles is positively related to both intelligence and DSy performance, it may constitute another type of intellective process involved in the DSy Test. Fischer (1969) has recently suggested that intelligence itself may be defined as the effectiveness of an individual's approaches to certain situations. At the very least, the various ways of approaching the DSy task provide promising leads as to what DSy measures besides motor speed and some highly specific form of learning. Factor analytic studies of DSy provide another potential source of promising hypotheses.

Factor Analysis of DSy

In his summary of factor analytic studies of DSy, Wechsler (1958) concluded that DSy is multiply determined, and therefore, factorially ambiguous. His discussion of factors which had significantly loaded DSy in various studies included the following: the general communal intellective factor (g), nonverbal organization, a verbal factor, memory (or freedom from distractibility), numerical fluency, perceptual speed, and an unidentified, specific DSy factor. Aside for "g" and nonverbal organization, memory or "freedom from distractibility" has most consistently loaded on DSy. Cohen (1952a) originally called this factor "freedom from distractibility," then he referred to it as "memory" (Cohen, 1957), but eventually reintroduced the original label (1959). The conflict between these two interpretations of this factor parallels the question of whether or not DSy measures learning. "Memory" would be an important factor in DSy if learning and subsequent remembering of the DSy associations were important, whereas "freedom from distractibility" might be an appropriate label, particularly if concentration and efficiency in copying were the key processes in DSy performance.

The importance of "freedom from distractibility" in DSy can be seen from our previous analysis of DSy performance, where speed and efficient, concentrated effort were judged to be of primary significance. In the DSy task, the S must work quickly with his percepts of the digits and the associated symbols, or else they may be forgotten, thus requiring an additional visual search of the code key. In one sense, a "freedom from distractibility" factor can be understood as the alertness and concentrated attention required for efficient DSy performance, with the "memory" aspect of the factor corresponding to the loss of DSy information from short term memory that seems to occur when the S is momentarily distracted from his task by an unproductive thought or stimulus.

In their clinical analysis of the DSy task, Rapaport and his associates (1945, p. 290) concluded that a speedy DSy performance is the "expression of a relatively undisturbed working of the organism," thus phenomenologically anticipating the statistically derived concept of "freedom from distractibility" or in Rapaport's words, the "undisturbed working of the organism." In describing the visual-motor aspect of DSy, Rapaport and his associates (1945, p. 290) emphasized, in effect, how susceptible this task is to any distraction:

> The visual-motor coordination in this subtest is expressed in the tuning together of the visual percept (or memory) of the symbol and digit, the spatial-visual and spatial-motor orientation, and the executive half-habituated action of drawing. It is small wonder that such a delicate interaction is easily disturbed from any side.

Although DSy's loading on the "freedom from distractibility" factor has usually been significant (Cohen, 1952a, 1952b; Dennerll, Broeder, & Sokolov, 1964), the emergence of a specific or quasi-specific "Digit Symbol factor" (Cohen, 1957, 1959) tends to reduce DSy's loading on "freedom from distractibility" or restrict it to certain age ranges. According to Berger and his associates (Berger, Bernstein, Klein, Cohen, & Lucas, 1964), the failure of Cohen's (1952a, 1952b) early studies to reveal this major quasi-specific factor is due to the use of inadequate, subjective factor analytic techniques which were limited to three factor solutions. More extensive and objective rotational techniques reportedly allowed for the emergence of this additional main factor. These authors pointed out that when Cohen himself applied more than a three factor solution, he also obtained an additional quasi-specific DSy factor for adults (1957) and children (1959). Since DSy is the only subtest to load consistently on this factor, it has remained uninterpreted. Sometimes it loads exclusively on DSy (Cohen, 1959), but Cohen (1957) also found it to load Digit Span and Picture Arrangement, but only in certain age groups (18-19 and 45-54, respectively). Its loading on DSy decreases markedly for Ss in the old age sample, from 60 years onward. Thus, Cohen (1957, p. 286) concluded:

> Apparently, the specific ability demanded by Digit Symbol at younger ages ceases to be important in senescence, and three other factors which had previously not affected Digit Symbol begin to do so.

Berger and his associates (1964) found the "DSy factor" to be the most unstable of the four major factors which emerged from their analysis. Factorial dissimilarity increased among groups of increasing age and was considerable among different diagnostic categories on this factor. The only exception to the negligible similarity of the pathological groups on this factor was a considerable correlation (.72) between the chronic schizophrenic and brain damaged samples. The authors suggested that this similarity might be due to some degree of brain damage which may be found in the chronic schizophrenic as well as the brain damaged group.

In summary, it appears that DSy measures somewhat different abilities depending on the age and diagnostic category of the Ss. Further evidence for this conclusion is available from other factor analytic studies as well. Cohen (1952a, 1952b) found that for a large sample of patients, DSy loaded heavily on the "freedom from distractibility" factor for neurotics and schizophrenics, but loaded the nonverbal organization factor for brain damaged Ss. In this study, Cohen noted that among the performance tests, DSy was second only to Block Design in its ability to predict general intellectual functioning. Cohen (1952b) noted that in loading on the nonverbal organization factor for organics, DSy seemed to measure the same functions as the other performance tests, but for neurotics and psychotics, it apparently measured different functions than those measured by Object Assembly, Block Design, Picture Completion, and Picture Arrangement, the remaining performance subtests. Dennerll, Broeder, and Sokolov (1964) reported that, as in previous research, DSy was found to be more factorially complex in the epileptic adult group than with the normal group. In general, it is apparent that DSy measures somewhat different abilities in different populations.

While DSy is by no means unique in this respect, it is factorially unique in other respects. For one thing, the repeated verification of a specific or quasi-specific "DSy factor" is totally unique except for the occasional finding of a "Picture Completion factor" (Cohen, 1957). Furthermore, DSy often has very little factorial similarity to other subtests of the Wechsler scales. In his factor analysis of the WAIS, Maxwell (1960) found that DSy did not share common factor loadings with the other performance tests. In studies already discussed, DSy often differed significantly from the other performance tests for certain samples (e.g. Cohen, 1952b). Wechsler's (1958) data indicated that DSy correlated higher with level of education than any other performance subtest, and surpassed many of the verbal subtests in this regard. Similarly, Wechsler (1958) has noted that DSy has sometimes loaded moderately on a verbal factor, even though it is generally accepted as a test of psychomotor speed.

Quantitative support for this stems from the WAIS standardization data. Wechsler (1955) reported the intercorrelations of the WAIS subtests for ages 18 to 19, 25 to 34, and 45 to 54, and in each of these three age groups the DSy Test correlated higher with the verbal scale than with the performance scale. The correlations between the DSy Test and the performance scale were corrected for the effect of DSy's inclusion in the performance scale. Following the same procedure, Doppelt and Wallace (1955) reported the intercorrelations of the WAIS subtests for four age groups of elderly Ss, ages 60 to 64, 65 to 69, 70 to 74, and 75 or older. In the oldest age group (75 or older), the DSy Test correlated higher with the verbal scale than with the performance scale. However, in the other three elderly groups, the DSy Test correlated higher with the performance scale. Nevertheless, it is significant that in four out of the seven age groups examined, the WAIS DSy Test correlated more highly with the verbal scale than with the performance scale. As Guertin and his associates (Guertin, Ladd, Frank, Rabin, &

Hiester, 1966, p. 395) concluded, the DSy Test "does not seem to be the same kind of task as the other nonverbal tasks."

This review of factor analytic studies has suggested several important characteristics of the DSy Test: (a) In addition to its loading on "g," DSy sometimes loads moderately on a performance or nonverbal organization factor. Thus, under some conditions, DSy has something in common with the other performance tests, which perhaps is the visual-motor channel itself. (b) It sometimes loads on factors such as numerical fluency and perceptual speed. These may be taken as representing skills involved especially in the input of DSy information, perhaps corresponding to the visual search and assimilation process hypothesized from a phenomenological analysis of DSy. (c) A "freedom from distractibility" or "memory" factor is often of primary importance in DSy, further emphasizing the hypothesized importance of concentrated attention and efficiency of approach. (d) A quasi-specific or specific "DSy factor" consistently appears in more complex and objective factor analyses, and as yet remains unidentified. It often accounts for the largest amount of reliable variance in this subtest (Cohen, 1959), and apparently is based on some ability which is usually of little importance in the other Wechsler subtests. (e) In general, DSy does not seem to belong factorially with the other performance subtests. It predicts level of education better than some of the verbal subtests, and at many age levels it correlates higher with the verbal scale than with the performance scale. Perhaps more than any other Wechsler subtest, DSy is factorially unique.

Phenomenological and factorial analyses of DSy tend to converge on several types of variables of apparent significance in DSy performance. These include motivation, efficiency of performance style, attention variables, age, psychopathology, personality, and an array of visual, motor, and cognitive processes. These and other variables will be examined under the following headings: Energy Deployment, Conditions of Behavioral Inefficiency, Sex Differences, Handedness, and Experimenter and Procedural Effects.

Energy Deployment

Wechsler (1950) noted that the "energy level" of a S can be inferred from his DSy performance. "Energy deployment" as used by Wachtel and Blatt (1965) is basically a motivational or dynamic concept, with degree of efficiency implicitly associated with it. Whereas "energy level" tends to imply a degree of motivation or a readiness to perform energetically, "energy deployment" implies an actual energy expenditure. Furthermore, two Ss may expend the same amount of energy, yet one's efforts may be better focused and effective than the other's. Thus, Wachtel and Blatt (1965, p. 303) used the WAIS DSy as a measure of "the capacity for directed, focused, and efficient expenditure of energy." Allison, Blatt, and Zimet (1967, p. 31) described DSy as primarily "a measure of the capacity to utilize energy in a simple task." DSy therefore "reflects the amount of energy output a subject can generally bring to his work and his activities." Wachtel and Blatt (1965) pointed out that energy is the capacity to do work. In this sense, DSy measures the ability to do work.

Glasser and Zimmerman (1967) have apparently accepted a similar interpretation of the Coding subtest of the Wechsler Intelligence Scale for Children (WISC), which is DSy's counterpart in the children's form of Wechsler's intelligence scale, and according to Cohen (1959) it is factor analytically equivalent to it. However, Glasser and Zimmerman failed to emphasize the efficiency aspect of energy deployment, concluding simply that Coding "seems to be measuring motivation rather than any aspect of intelligence (p.94)."

Oakland (1969) sought verification for this interpretation of Coding by examining a group of 25 youths who had been physically handicapped from birth. The group included both males and females, ranging in age from 5 to 20 years old. The one 20 year old, a male, was administered the equivalent WAIS DSy instead of the WISC Coding Test. The intelligence quotients of the Ss ranged all the way from 66 to 120. The professional staff rated the Ss on a nine point motivation scale which was designed to distinguish the "apathetic" from the "achievement oriented" children. Ratings of achievement orientation correlated .51 ($p < .005$) with Coding scores, suggesting that Coding or DSy performance does measure some aspect of energy level or motivation. What makes this conclusion tenuous, however, is the confounding of motivation with related personality traits that were used to help define the variable being rated. Thus, "apathetic" was defined, not only by such adjectives as "listless" and "lethargic," but also by related but distinct personality descriptions such as "seldom feels or shows emotion, is mechanical..., unquestioning..., and very dependent on others (p. 411)." "Achievement oriented" was defined by terms such as "energetic," "alert," and "mentally active," but also by terms such as "emotionally responsive," "self-confident," and "questioning." In a broad sense, the rating scale may have reflected a general adjustment variable rather than simply a motivational one. Its correlation with DSy suggests that DSy does not measure motivation alone, but a whole complex of characteristics that are related to the adaptive, efficient functioning of the S.

In sections which follow, the relationship of DSy to "conditions of behavioral inefficiency" will be examined, particularly with respect to DSy as a measure of efficient, adaptive energy deployment, or the ability to do work. When a person is unable to channel his energy and ability efficiently into a specific task or into his daily activities in general, he is manifesting a condition of behavioral inefficiency, or maladaptive behavior in a broad sense of the term. The "conditions" of behavioral inefficiency can consist of both the characteristics of the person himself such as organicity, emotional disturbance, and trait anxiety, and of the environmental and situational conditions which the person finds himself in such as stressful, frustrating, and anxiety provoking circumstances.

Although the present author will attempt to demonstrate DSy's usefulness in predicting numerous conditions of behavioral inefficiency, the only specific condition to which the notion of efficient energy deployment has been applied so far has been the problem of underachievement. Wachtel and Blatt's (1965) clever study of energy deployment and achievement stands as the most crucial, direct test of the efficient energy deployment hypothesis. For this reason, the first condition of behavioral inefficiency to be examined here is underachievement.

Conditions of Behavioral Inefficiency

Underachievement. It has long been common knowledge among educators that intelligence alone is not adequate to accurately predict academic achievement. Kessler (1966) reported that correlations between intelligence and achievement range from .40 to .70. Thus, the amount of variance in achievement scores that is accounted for by intelligence ranges from a mere 16% to a moderate 49%. What factors can account for the remaining 51% or more of the variance? Among the probable nonintellective components of achievement are motivational factors. Dulin (1968), in a will planned longitudinal study of achievement among college students, found that achievement motivation was more important than intelligence in subsequent academic achievement, at least among his S̲s, who as college students were above average in intelligence. Correlations between grade point average and intelligence were smaller at all four year levels than those between grade point average and achievement motivation. For example, when his S̲s were freshmen, their grade point averages and Henmon-Nelson Test of Mental Ability scores correlated .44, while their grade point averages and Story Sequence Analysis motivation scores correlated .84. Clearly, both motivation and intelligence are important in achievement.

Inasmuch as DSy performance is currently thought by some to reflect motivational factors even more than intellectual ones (Allison, Blatt, & Zimet, 1967; Glasser & Zimmerman, 1967; Sherman & Blatt, 1968; Wachtel & Blatt, 1965), it might well be able to predict achievement better than more purely intellective measures of intelligence. This, in fact, was one of the findings of Wachtel and Blatt (1965) whose experiment also provided a convincing validation of DSy as a measure of efficient energy deployment. Acknowledging Wishner's (1955) distinction between focused and diffuse energy expenditure, the authors reasoned that the number of symbols correctly reproduced, the DSy score itself, would reflect whatever energy had been deployed directly and appropriately on the required task, while excessive pencil pressure in drawing the symbols would represent an irrelevant, inefficient, and diffuse deployment of energy.

Pencil pressure was measured by placing a set of manifold carbon papers under the DSy sheet, so that the number of sheets upon which carbon copy markings of the symbols were visible provided a measure of the pencil pressure applied. Judgments of visibility were made by an independent judge who used both ascending and descending determinations, using the average as the Ss score. Interrater reliability for this method of measuring pencil pressure was acceptable (r = .86). This method of measuring pencil pressure would be questionable if many Ss were aware of the carbon sets. Inferring that the E wanted carbon copies of their performance, some Ss might try to press very hard in a spirit of cooperation. However, the authors found that none of the Ss were able to report any awareness of the carbons. Blatt (Personal communication, 1970) explained that the carbon sets were cut somewhat smaller than the DSy sheet. Since the DSy was administered individually, the Ss had no time to examine the sheets and therefore were unaware of the carbon paper.

The achievement variable was defined both by academic and extracurricular criteria, thus eliminating extremely introverted, schizoid "achievers" and well adjusted, successful "underachievers." A high achiever was defined as a student whose grades put him in the top third of his class and whose extracurricular record showed no serious poverty of social activity. A low achiever was identified by his academic position in the bottom third of his class and his participation in extracurricular activities. High achievers and low achievers did not differ in intelligence as measured by the Vocabulary and Information subtests of the WAIS.

Other variables investigated included anxiety, measured by the Freeman (Freeman, 1953) Manifest Anxiety Scale (FMAS) and self-regard, measured by discrepancies between a S's self description and a previously established "ideal" description, using a ranking of 20 descriptive paragraphs derived from Murray's list of needs. The 38 college students chosen to be Ss had previously been administered the self-description test as a class exercise in introductory psychology. These Ss were interviewed briefly to establish rapport, and then were administered the FMAS, followed by a three minute lengthened version of the WAIS DSy Test, which was emphasized as a test of intelligence. Followed by a dramatized "failure report," the DSy Test was readministered.

The results of this experiment were highly informative. Even though the high achievers and low achievers did not differ in intelligence, the high achievers were unquestionably superior in DSy performance scores before and after application of the failure stress ($p < .005$). Thus, at least with this population, DSy performance not only predicts general achievement, but it does so independent of its validity as a test of general intelligence. Furthermore, it was found that low achievers applied significantly more pencil pressure than high achievers ($p < .05$), both before and after the failure condition. This is unequivocal support of DSy as a measure of efficient energy deployment. The excessive pencil pressure was clearly associated with inefficient DSy performance.

Wachtel and Blatt did not speculate on just how this excessive pencil pressure results in lower DSy scores, except to suggest that (p. 302) "deployment of energy in one activity decreases the amount which can be utilized in others." Presumably, this was meant to imply that the more energy the S invests in pencil pressure, the less he will be able to invest in correct reproduction of as many symbols as possible. An admittedly broad generalization of this formulation would be that the more energy a S invests in unimportant qualitative aspects of performance, the less he will be able to invest in the important quantitative aspect of performance. Intuitively, it seems plausible that pressing the pencil down hard on the paper might not only require more energy than pressing lightly would, but it might also be associated with a more time consuming, laborious, compulsive approach to drawing the symbols. In terms of the various approaches to performance of the DSy task, this would correspond to a relatively compulsive performance style. Of course, an individual S could draw the symbols rapidly and/or impulsively, and still press hard on the paper, but it is the present author's hypothesis that speed, impulsivity, and light pencil pressure are positively intercorrelated, as are slowness, compulsivity, and heavy pencil pressure.

Other results of the Wachtel and Blatt (1965) experiment include the finding that there was no significant difference in anxiety between high achievers and low achievers on either administration of the DSy task. However, improvement in DSy score under failure stress correlated negatively ($r = -.27$, $p < .05$) with anxiety. Examining this finding in relation to level of self-regard, the authors found that the inverse relationship between anxiety and amount of improvement under stress was significant only for the low self-regard group ($r = -.63$, $p < .005$), with the high self-regard correlation (-.05) and the low self-regard correlation (-.63) differing significantly ($p < .05$). The authors concluded that "the attitude toward the self may interact with anxiety in determining the effect of anxiety upon functioning (p. 306)." The variable of self-regard in itself did not significantly affect DSy scores either before or after the failure stress condition.

The importance of Wachtel and Blatt's (1965) experiment is threefold. It demonstrated that DSy performance is directly related to achievement, that DSy pencil pressure is inversely related to both achievement and DSy performance, and that DSy is a measure of efficient energy deployment. Further information about DSy as a predictor of level of achievement comes from several other sources. Just as underachievers apparently invest too much energy in excessive DSy pencil pressure, the findings of Mondani and Tutko (1969) suggest that they also invest too much energy in extraneous learning while failing on the central task. These authors found that underachievers showed significantly more incidental learning than achievers did ($p < .01$). Thus, underachievers may not only work as hard as achievers, but they may also learn as much as achievers. The distinction appears to lie in the efficiency of the work and the appropriateness of what is learned. For example, the student who spends most of his study time over-investigating some small aspect of the course material which interested him may be learning just as much as the achiever, but will be likely to obtain low grades on general course exams, and hence will become an "underachiever." Some of the most creative students undoubtedly fall into this category. However, even students who are studying the appropriate course material may nevertheless do it in an inefficient manner, just as they may spend their test time inefficiently.

Like Wachtel and Blatt (1965), Lazarus and Erickson (1952) found that the DSy performance of high achievers improved significantly more than that of low achievers following a failure communication. Particularly for a S of low self-regard (Wachtel & Blatt, 1965), a failure report may not only increase drive level, but also increase the underachiever's inefficiency and disorganization. Unlike Wachtel and Blatt (1965), Murstein and Leipold (1961) found DSy to be unrelated to a measure of "intelligence" which actually was based on academic achievement. However, indirect support of DSy as a predictor of achievement comes from its correlation with educational level. Educational level of advancement implies academic achievement inasmuch as high achievers tend to stay in school and underachievers tend to drop out. High DSy scores often tend to be associated with high levels of education (Wechsler 1958; Willoughby 1929, 1930). For example, in a population of 300 Ss, ranging in age from 6 to over 68, (Willoughby, 1929, 1930) DSy correlated .797 with education level. Corrected for "truncation," this correlation became .986. However, the correlation between DSy and intelligence was also very high (r = .80), suggesting that intelligence itself accounted for much of DSy's relationship with level of education.

In summary, little direct experimental evidence is available regarding the relationship between DSy and achievement, but the best research to date suggests that DSy score is positively related to achievement, while excessive pencil pressure is inversely related to achievement and DSy performance. In groups of homogeneous intelligence level, DSy pencil pressure can apparently be used as a predictor of underachievement. The underachiever may work as hard and learn as much as the achiever, but his efforts tend to be inefficient and misdirected.

Reading disability. A reading disability sometimes is one component of a student's underachievement problem. While the inefficient energy expenditure hypothesis is a plausible explanation of general underachievement, its application to reading disabilities is not as simple. It is not difficult to see how a student's inefficiency in a DSy task may generalize to his scholastic work. He may work hard on his assignments but may emphasize peripheral, irrelevant aspects of the lesson rather than the central concepts. He may expend tremendous effort on tangential subjects of interest, but flunk a test on the assigned lesson. His study habits may be grossly inefficient and unproductive although he may study as diligently as the achiever. Can similar mechanisms be cited for reading disabilities?

In a limited sense, an affirmative answer may be given tentatively to this question. Thus, the S whose eye movements in reading are irregular and confused is functioning inefficiently, using eye movements which are unproductive and ineffective.

Even the S who is physiologically capable of reading at a fast rate may habitually read ponderously, focusing individually on each and every word in the passage and may even reread unimportant phrases even if he has already comprehended their basic meaning. It would seem, however, that many of the behavioral inefficiencies involved in a reading disability come under very little or no conscious, voluntary control, and therefore, are of a different nature than the behavioral inefficiencies which have been hypothesized for general underachievement. Kessler (1966) discussed several varieties of reading disabilities or types of causitive factors including: visual deficits, mixed cerebral dominance, brain damage, inadequate instruction, poor motivation, and emotional problems.

With such a great variety of factors determining reading ability, it would seem improbable that any one subtest of the Wechsler scales could predict reading disabilities in general. Nevertheless, Coding, DSy's equivalent in the WISC, has consistently been one of the best predictor's of reading disability. Huelsman (1970) summarized the results of 20 studies of the relationship between reading disability and the Wechsler subtests, and concluded that the "disabled reader" pattern on the WISC would include especially low scores on Information, Arithmetic, and Coding. In 19 out of 20 studies, DSy was among the lowest of the subtests and in the twentieth it was intermediate. DSy was second to Arithmetic in its consistently low ranking among the WISC subtests.

Note that DSy is the only performance subtest which is useful in predicting reading disability. Graham (1952, pp. 270-271) observed that, outside of the verbal subtests, DSy "most closely resembles the original reading learning situation." Well coordinated eye movements are especially significant in both reading and DSy performance, so that this may be the critical element of the DSy task which relates so well to reading performance. In DSy performance, the usual approach is to look at the digit, shift the eyes to the code key, searching out the appropriate symbol, and then shift one's glance back to the proper square in the test form. Except for the actual writing of the symbols, DSy depends heavily on visual processes. The S with a reading disability will do poorly on DSy for the same reason he does poorly in reading, be it a matter of motivation, organicity, visual deficits, or anything else, including the general factor of inefficient energy deployment.

Psychopathology and personality. Relative to the other Wechsler subtests, DSy did not receive much attention from such masters in the field of diagnostic testing as Rapaport and Schafer (Rapaport, et. al., 1945; Schafer, 1948). Having thoroughly searched the literature on the diagnostic utility of the Wechsler scales, the present author concludes that DSy is still regarded generally as providing little information about a S's personality or psychopathology. DSy's utility appears to be limited by its simplicity and homogeneity. Most typically, the E obtains one simple score and limited observational data. Since most Ss obtain full credit for most, if not all, of the items which they complete, and since there are no hypotheses typically attached to failure of particular items, there is no meaningful intra-test scatter to analyze. Nor does it ordinarily elicit any verbalizations that can be interpreted clinically. Furthermore, the nature of the test is apparently so mechanical and simple, that it is difficult intuitively to imagine what of significance is being demanded of the S beyond the requirements of a simple visual-motor speed test. Finally, the actual performance of the S requires a mere 90 seconds on the WAIS—hardly enough time to learn much about a complex human being. In spite of all these negative factors which apparently lead clinicians to expect little diagnostic utility in the DSy Test, it appears to be relatively adequate in this regard, and even contributes some unique information not available from the other subtests. The next several pages will be devoted to the documentation of this conclusion.

Rapaport and his associates (1945, p. 299) summarized much of DSy's diagnostic utility very concisely:

> Weighted scores of 7 or less are practically absent in Normals, even those inclined toward depressive

> mood swings. This gives emphasis to the point that a relatively poor performance on Digit Symbol is generally a sign of pathological depression or, less frequently, of some Schizophrenic disturbance.

If DSy had no other utility, the validity of the above statement alone would make DSy a powerful aid in diagnostic assessment in clinical populations and maladjustment screening in normal populations.

Although DSy's validity as an inverse measure of depression may be widely accepted in clinical practice, it has not met with comparable acceptance in the experimental literature. Beck (1967, p. 155) recently concluded that "although the depressed patients tend to complain of cognitive inefficiencies, they perform as well in test situations as do non-depressed patients." In support of this conclusion, Beck cited several studies (Friedman, 1964; Granick, 1963; Loeb, Beck, Diggory, & Tuthill, 1967; Shapiro, Campbell, Harris, & Dewsberry, 1958; Tucker & Spielberg, 1958) including one on DSy which was conducted by himself and his associates (Beck, Feshback, & Legg, 1962). Rapaport, Gill, and Schafer (1945) had found that their depressed patients did even more poorly on DSy than their schizophrenic patients, thus supporting their contention that DSy was especially vulnerable to depression. However, Beck and his associates (1962) noted that Rapaport's depressive patients were considerably older, on the average, than his schizophrenic patients.

Controlling for intelligence as well as age, they found that in their sample of 178 psychiatric patients, DSy was inversely related to severity of psychopathology, but unrelated to level of depression. Fisher (1949) reported that improvement in DSy score following electroshock therapy was positively related to degree of general improvement in the depressed patients. Beck and his associates (1962) pointed out, however, that the significant improvement in DSy performance could have been the function of a decrease in general psychopathology rather than depression as such. Thus, even though depressed patients may sometimes work more slowly on DSy, there is evidence to suggest that DSy is more sensitive to severity of psychopathology than to level of depression. Psychotic depressives perform more poorly than depressed neurotics, but the psychotics are not only possibly more depressed; they are also certainly more disturbed.

Although clinicians may most commonly accept Rapaport's contention that a relatively low DSy score is often due to severe depression, there is more support for his interpretation of a relatively low DSy score as a sign of schizophrenia. The numerous attempts to establish reliable subtest scatter patterns in the Wechsler scales which would differentiate one diagnostic group from another were not particularly successful (Guertin, et al., 1956), but collectively, they provide a vast amount of data on the effect of psychopathology on cognitive functioning, including DSy performance. Combining the data from 17 such studies which had been reported in the literature by 1956, Payne (1961) computed the subtest mean scale scores of over 1700 psychiatric patients, including 1107 schizophrenics. The most reliable pattern found was for schizophrenia, in which Vocabulary (9.73) and Information (9.32) tended to hold up the best, while Digit Symbol (7.07) was lowest of all, followed by Digit Span (7.53) and Arithmetic (7.55) which also were reliably low.

However, as was generally the case in the subtest pattern studies, significant sex differences apparently were uncontrolled. A consideration of sex differences is relevant here because DSy is one of the Wechsler subtests on which a consistent sex difference occurs, with females often doing significantly better than males (Boor & Schill, 1967; Gainer, 1962; Goodstein & Farber, 1957; Miele, 1958; Minuchin, 1963, 1964; Norman, 1953; Shaw, 1965; Wechsler, 1958). In the subtest pattern studies conducted in the 1940's and early '50's, the sex of the <u>S</u>s was seldom even reported, although most of the V. A. patients used were probably males. Even when the sex of the <u>S</u>s was reported, it was not uncommon to have different proportions of males and females in different diagnostic categories, and yet not report separate statistics for males and females. Furthermore, when normal control groups were used, they often consisted of student nurses, predominantly females, while the patients were most often males. Since so many studies apparently employed only male patients, often without a normal control group, the consistently low ranking of DSy among schizophrenic patients could have been due to the sex of the Ss rather than their schizophrenia. Diagnostic categories sometimes differed on other important variables as well, including age, education, and intelligence. However, even when these key factors have been controlled, the sensitivity of DSy to schizophrenia has sometimes been confirmed (Garfield, 1949; Weider, 1943).

Weider (1943), for example, used female Ss exclusively for both the schizophrenic and normal samples, thus holding the sex factor constant. Twenty schizophrenics ranged in age from 16 to 28 years old, and 30 older schizophrenics ranged from 30 to 49 years of age. Matched for full scale I.Q. with 50 normal Ss of similar age, the schizophrenics had particular difficulty on DSy while the normal females did especially well on this subtest. For both age groups, DSy ranked as the lowest subtest in mean scaled score among the schizophrenics, but ranked as the highest scoring subtest among the normals.

Garfield (1949) found that regardless of age, education, intelligence and type of schizophrenia, DSy was most consistently the lowest of the subtests among the 109 male schizophrenics studied. The possible effect of sex differences in

DSy could not be assessed, however, since no female Ss were employed, and no control group was used. More recently, Orzack and Kornetsky (1966) controlled age, education, and sex, and failed to find a significant decrement in DSy due to schizophrenia, although there was a strong trend suggesting the superiority of the normals ($p < .10$). The failure of the authors to confirm the findings of Weider (1943) may have been due to the small number of Ss tested: 16 schizophrenics, half males and half females, and 13 staff members, including 7 males and 6 females. Furthermore, Orzack and Kornetsky motivated the patients with rewards such as cigarettes and tokens, which perhaps adds a confound in assessing the effect of the schizophrenia as such.

However, if the failure of Orzack and Kornetsky (1966) to find a statistically significant decrement in DSy among schizophrenics was not due to these technical factors, then their results may be due to the confounding of two contrasting schizophrenic processes. As Wechsler (1958) has noted, most schizophrenics are impaired in DSy performance, but others do surprisingly well. Rapaport and his associates (Rapaport, et al., 1945; Schafer, 1948) have attributed this DSy ability of some schizophrenics to their blandness. Allison, Blatt, and Zimet (1967, p. 33) explained that DSy "deals with essentially neutral, content-less material." The symbols themselves are unlikely to elicit associations to interpersonal and emotional variables. Thus, some schizophrenics apparently can function more effectively when the test content is free from potentially disturbing stimuli to which the schizophrenic may free associate. Wechsler (1958, p. 127) suggested that the schizophrenics who do poorly on DSy do so because of "inner distraction," while those few who do well do so because of "obtuseness to outer stimulation."

Although Gaston and DeLange (1961) did not specify how many of their <u>S</u>s were schizophrenic, their study is discussed here because of the additional insight it suggests regarding those schizophrenics and other psychotics who do relatively well on DSy. These authors examined the WB I protocols of 576 hospitalized psychiatric patients, and found 41 patients whose DSy score was highest among their performance subtest scores. These patients were matched for sex with 41 other psychiatric patients who were used as control <u>S</u>s. The findings were that those patients whose DSy scores ranked highest among the performance subtests tended to carry a psychotic diagnosis ($p < .001$). They also tended to be females ($p < .001$). For the remainder of the 576 patients, no information was provided regarding the relationship between DSy and psychosis or that between DSy and sex. The predominance of females in this high DSy group is not surprising, but the prevalence of psychosis among the high DSy <u>S</u>s seems inconsistent with most of the literature except for the different manner in which these patients were selected. By selecting only the Ss who did better on DSy than on all of the other performance subtests, the authors may have selected those relatively few patients who do extremely well on DSy because of their blandness (Rapaport, et al., 1945; Schafer, 1948) or obtuseness to distracting stimulation (Wechsler, 1958). An alternative explanation is that the DSy superiority of the female psychotics may have been due to their sex rather than their psychosis. Although it is unclear from the data reported, it appears that most if not all of the superior Ss were female as well as psychotic.

Additional clinical information concerning these patients was provided by Gaston and DeLange (1961). They were able to discern certain differences between these high DSy psychotics and the other psychotics among their larger population of 576 patients. In this regard, the authors wrote (p. 79):

> It was noted that the DSy High patients often presented a diagnostic problem. Most of them evidenced a definite psychotic quality to their thinking but without the loss of affect often associated with schizophrenics.... Also, many of these patients seemed to achieve an apparent remission of their psychotic symptoms in a relatively short period of time.

Thus, the psychotics who do well on DSy may tend to be less disturbed affectively and seem to have a better prognosis. These suggestions are highly tentative, but they provide a possibly fruitful direction for future research.

As in the case of Rapaport, Gill, and Schafer's (1945) contention regarding DSy and depression their hypothesis regarding DSy and schizophrenia has recieved only partial and highly qualified support. It appears that even when variables such as age, sex, education, and intelligence are controlled, a very low DSy score is often predictive of schizophrenia. However, a very high DSy score in a psychiatric population also may be predictive of schizophrenia or some other psychosis even though this latter relationship may be more rare. While DSy performance may be related to schizophrenia it seems also to be related to other psychoses and may be related to psychopathology in general, more than any other Wechsler subtest is. Outlining the hypothesized characteristics of various clinical groups, Wechsler (1958) listed a relative decrement in DSy score for every clinical category considered. Relative to the patient's mean subtest score, the DSy score is expected to be low in cases of anxiety states and schizophrenia, and extremely low in cases of organicity. Among mental defectives, the DSy score is expected to be moderately low or average, and among adolescent sociopaths, it is expected to remain close to the mean scale value or slightly lower.

Where subtest rankings or scale scores have been reported, DSy has often been the lowest subtest in numerous clinical groups, including schizophrenia (Garfield, 1949; Gilliland, Wittman, & Goldman, 1943; Margaret, 1942; Olch, 1948; Rabin, 1942; Weider, 1943), brain damage (Aita, Armitage, Reitan, & Rabinowitz, 1947), brain disease (Allen, 1948), epilepsy (Loveland, 1961), neurosis (Gilliland, et al., 1943), manic-depressive psychosis (Gilliland, et al., 1943; Rabin, 1942), involutional depression (Rapaport, et al., 1945), and severe neurotic depression (Rapaport, et al., 1945). Although DSy may usually be low in cases of psychopathology, "normals" in some studies have also scored poorly on DSy. For example, Gilliland and his associates (1943) tested 100 state hospital attendants as control Ss and found that DSy was one of their two lowest subtests. Inasmuch as attendants are generally males, the low DSy scores of the attendants as well as those of the patients may simply reflect a sex difference.

In the differential diagnosis of organicity, however, DSy is consistently useful. Aita, et al., (1947) found that even when neuropsychiatric controls and organics obtained nearly identical DSy rankings relative to the other subtests, the two groups still differed significantly in DSy performance, with the brain damaged being inferior. That is, no matter how low other groups score because of sex differences or psychopathology, brain damaged patients tend to score even lower. Morrow and Mark (1955), for example, compared brain damaged patients to psychiatric and surgery control groups. An average weighted score of 4.23 for the organics was obtained, compared to scores of 9.14 and 10.40 for the psychiatric and surgery controls, respectively. Thus, the size of the decrement in DSy score which occurs in organicity is not only a statistically significant difference; it is a gross decrement, marked enough for use in individual clinical diagnosis. Gonen (1970) recently confirmed the reliability of DSy's decrement in organicity in all 24 of his cases. No other subtest surpassed DSy in this regard.

Ladd (1964) found his 50 brain damaged patients to be significantly inferior to his 75 neurotic patients on DSy ($p < .01$), which was superior to other subtests in discriminating the two diagnostic categories. Block Design, Picture Arrangement, and Object Assembly were also predictive of brain damage. Cohen (1952b) had found that DSy does not share much common variance with the other performance tests for neurotics or psychotics, but it does for organics. Morrow and Mark (1955) found that the DSy scores of organics were depressed significantly ($p < .001$), relative to neurotic and "mildly schizophrenic" patients. Besides contributing to the differential diagnosis of organicity, DSy also has been used in attempts to localize the site of the brain damage (Balthazar, 1963) and to estimate age of onset (Fitzhugh & Fitzhugh, 1965). In the former research (Balthazar, 1963), WB II DSy and Block Design were depressed by damage in either hemisphere, but Object Assembly was depressed only by damage in the right hemisphere, thus providing the basis for differentiation. In the latter study, (Fitzhugh & Fitzhugh, 1965), 60 patients were matched on age, education, sex, color, and handedness. The patients who had incurred the brain damage at the average age of approximately 3 years old were more impaired in DSy performance ($p < .05$) than those whose damage occurred at the average age of approxiamtely 15. In this study, Picture Completion and Object Assembly also were sensitive to age of onset.

The nature of the organic's deficit on DSy is presumably a visual-motor one which may be aggravated by the stress of the rigid time limit. The organic is not only faced with the pressure of the time limit, he also has to shift his vision constantly from the test item to the code key and back to the next test item, while coordinating his motor responses in writing the appropriate symbols. Comparing DSy to other Wechsler motor tasks, Allen (1947, pp. 228-229) noted that:

> The necessity for constantly shifting at the completion of each number-symbol task is not present in the object assembly and block design subtests. This continuous physical and psychological orientation process of digit symbol association poses an additional difficulty for the brain injured....

Another clinical syndrome which is related to DSy performance is epilepsy. Examining 26 epileptic outpatients and an equal number of control Ss matched for sex, age, education, race, intelligence, and socioeconomic level, Loveland (1961) found that DSy score, but not the number of DSy errors, differentiated the two groups better than chance ($p < .01$). DSy score was one of 6 variables out of 120 which were significantly predictive of epilepsy. In this well controlled study, DSy ranked as the lowest Wechsler subtest for epileptics, but the highest for the control group.

Levinson (1964) has worked with a population that is not usually classified as a clinical category, but one which is undoubtedly plagued by a wide range of psychopathology, including psychosis, alcoholism, and brain damage, as well as physical, emotional, and mental deterioration. Vagrant, derilect, bum, drunk—the "skid row" resident is described in a variety of demeaning ways, all of which emphasize his generally low level of functioning. If DSy is a good measure of efficient functioning and freedom from debilitating conditions, it should be among the most depressed subtests in this population. Levinson (1964) confirmed this assumption with a sample of 182 "skid row men," finding that among four groups of these men, DSy was consistently either the lowest or second lowest mean subtest score. Levinson interpreted this finding as being a function of a motivational construct which he called the "beat" phenomenon. In other words, he regarded his Ss as "beaten men" who were downhearted, helpless, hopeless, and frustrated. The interpretation of DSy as a measure of "the capacity to do work (Wachtel & Blatt, 1965, p. 302)" would seem particularly appropriate here, considering the unproductive existence of these men. Levinson (1964) acknowledged, however, that many variables were undoubtedly confounded with the so-called "beat" phenomenon because of the lack of any control group. As has been the case in many of the studies of clinical psychopathology, the relative depression of DSy may have been due simply to the sex of the Ss.

Wishner (1955) has suggested that a continuum of mental health may be measured by the efficiency of energy expenditure that individuals achieve in meeting the demands of their environment. As a measure of efficient energy expenditure, DSy has been repeatedly related negatively to conditions of emotional, mental, and motivational pathology, thus supporting Wishner's conceptualization. Glasser and Zimmerman (1967) have recently suggested that the high degree of concentrated and sustained energy which is required in Coding, or DSy, make it (p. 94) "a measure of social adaptation, and hence maturity." Also recall Rapaport's (Rapaport, et al., 1945) contention that a DSy scale score of seven or less seldom is found among normals. This latter contention has not received the experimental attention which has been given to his formulations of DSy's vulnerability to schizophrenic and depressive conditions. The implication which needs to be tested is that DSy can screen out emotionally disturbed individuals from a normal population. A related hypothesis would be that DSy is not only inversely related to degree of disturbance in a psychiatric population, but it also is directly related to the mental health or level of adjustment in a normal population. Any test of this hypothesis should take into account the variables which have often confounded the effect of psychopathology on DSy performance: sex, age, education, and intelligence.

Tentatively, a few conclusions regarding DSy and psychopathology can be offered. DSy is apparently sensitive to a wide range of emotional, mental, and motivational disturbances, and seems particularly effective as an inverse measure of organic impairment, including epilepsy as well as brain damage and brain disease in general. While Rapaport's (Rapaport, et al., 1945) conclusion that decrements in DSy are usually indicative of pathological depression or, less often, of schizophrenia has received partial support, modifications in this conclusion are in order. Decrements in DSy do occur in pathological depressions, but may be due at least as much to the severity of the psychopathology as to the depth of the depression. Similarly, while DSy decrements are found in many schizophrenics, others do extremely well on DSy, suggesting that in a psychiatric population, very high DSy scores as well as very low ones may be indicative of schizophrenia. Further complications in using low DSy scores as signs of schizophrenia arise from the fact that many other mental disorders also result in lowered DSy productivity, especially in cases of organic impairment. Thus, DSy score cannot very well be used to diagnose schizophrenia in particular. It seems better conceptualized as an inverse measure of psychopathology in general and organic impairment in particular. Confirmation of these conclusions will necessitate the use of experimental designs which control for such variables as sex, age, education and intelligence.

The final score a patient earns on DSy need not be the only DSy variable considered in making a diagnostic formulation. Other variables such as pencil pressure, errors, and variations in performance style all convey potentially useful information to the diagnostician. For example, Schafer (1948, p. 66) has listed the following as qualitative signs of schizophrenia:

> frequent errors of copying other than changing the reversed N; frequent skipping of spaces and thereby entering what would have been the correct symbol in the wrong box; gross distortions of symbols; marked fluctuations of rate of work.

Thus, in a psychiatric record of poor DSy performance, the presence of these qualitative features would help distinguish schizophrenia from other conditions of pathology or behavioral inefficiency, particularly where tests such as Vocabulary and Information are relatively unimpaired. Rapaport, Gill, and Schafer (1945, p. 290) reported similarly, that "any repeated peculiar writing of a symbol" may sometimes result from "a schizophrenic misinterpretation of the symbol." Research with the Rorschach Test has sometimes (Levine, Glass, & Meltzoff, 1957; Levine, Spivack, & Wight, 1959) but not always (Fager, 1960) shown that those Ss who make the "N error" on the WB DSy tend to give more M responses, which are generally associated with desirable traits like intelligence, imagination, inner stability, self-acceptance, empathy, and others (Klopfer, Ainsworth, Klopfer, & Holt, 1954). The "reversed N" symbol was not retained in the contemporary WAIS form of the DSy Test, however. Wolfson and Weltman (1963), while not specifying the types of DSy errors made by their Ss, reported that early applicants to a nursing school (long term planners) made fewer errors ($p < .05$) than late applicants (short term planners).

Other personality traits have been clinically associated with DSy performance. Obsessive-compulsiveness is most easily observed on the DSy Test and has frequently been noted in the literature (Rapaport, et al., 1945; Glasser & Zimmerman, 1967; Payne, 1961). Perfectionistic, methodical, doubt-laden, hesitant, and overly controlled aspects of the obsessive-compulsive's performance are easily observed and may often lead to a qualitatively accurate but quantitatively unproductive performance. Contrasted to the compulsive style of DSy performance, an impulsive style is apparent in sloppy, hasty, inexact approximations of the symbols with a resulting high score minus the errors sustained in this approach. Although experimentally untested, a compulsive performance might well be characterized by excessive pencil pressure and "overworking" which is often observed in tests like the Bender-Gestalt. The impulsive S would probably tend to press lightly in his hasty reproductions of the symbols, perhaps extending them outside the boundaries of the squares, just as he strays outside the boundaries of the "alleys" of paper and pencil maze tests (Porteus, 1965). Similarly, the severe anxiety of many patients should often be seen in the tremulous quality of the drawn symbols. The effect of anxiety upon the DSy score itself is more complex and is discussed later in this review of the literature.

Discussing the WISC Coding subtest, the children's form of the DSy, Glasser and Zimmerman (1967) made numerous interpretive suggestions regarding its clinical use. They pointed out that, among other things, DSy performance can reveal difficulties in either or both the receptive (seeing) and expressive (copying) aspects of perceptual-motor functioning. Unfortunately, they did not suggest how to identify which aspect was causing the S's difficulty. However, they also made several unique observations including the assertion that low Coding scores are frequently caused by "the absence of challenge in the task for many children (p. 94)." Visual defects, visual-motor incoordination, poor pencil control, "associative inflexibility," emotional distractibility, and perfectionistic trends were also named as causes of deficient performance. The simplification of symbols, their reproduction in sequential order irrespective of the associated number, skipping squares more than once or twice, and drawing irrelevant symbols were suggested qualitative signs of severe disturbance.

Basing their interpretive analysis of DSy partly on its validity as a measure of "the capacity to utilize energy in a simple task," Allison, Blatt, and Zimet (1967, pp. 31-32) pointed out some diagnostic implications of the DSy score relative to other subtests:

> Thus, a low Digit Symbol, markedly below Vocabulary, is frequently a sign of depressive lack of energy output, whereas Digit Symbol above Vocabulary may be evidence of an overcompliant striving and a desire for achievement going beyond one's intellectual capacities.... Digit Symbol, when it is elevated above other Performance tests, indicates that reduced functioning in the other Performance tests may not be due to a lack of speed and low energy output, but rather to specific problems related to the unique functions tapped by these other subtests.

According to these authors, comparison between DSy and Digit Span is often particularly enlightening. Suggesting that a low Digit Span score is indicative of considerable anxiety, Allison, et al. (1967, p. 32) contended that the combination of a relatively low Digit Span and a relatively high DSy indicates that the <u>S</u> may be "controlling strong and pressing anxiety by excessive activity." Just as the <u>S</u> may expend a great deal of effort in his daily activities with the goal of pleasing others so as to avoid their attack and criticism, and hence reduce his anxiety, he will also expend considerable energy on the DSy Test, perhaps to please the E and avoid criticism.

The opposite pattern, a high Digit Span and a low DSy, was thought by these authors to characterize usually (p. 32), "an essentially depressed person who is attempting to ward off recognition of depressive affect...usually via denial, but not necessarily through activity...." An additional insight about DSy itself was also suggested. Inasmuch as DSy is the first subtest requiring the S to work with pencil and paper, it can often elicit reactions which exemplify the S's response to classroom demands, particularly if the S is currently a student. This characteristic may also help to account for DSy's validity as an inverse measure of academic underachievement tendencies.

Senescence. Another condition of behavioral inefficiency is senility. While extreme cases of senescence may overlap with clinical diagnostic categories, everyone who grows old falls victim to the aging process to varying degrees. The effects of old age on performance may be masked by some and delayed by others, but to date, no "fountain of youth," biochemical or otherwise, has been discovered. Since DSy performance is adversely affected by other conditions of behavioral inefficiency such as underachievement, emotional disturbance, brain damage, and vagrancy, it is not surprising that DSy performance declines in old age. Botwinick (1967) cited 10 studies of WB and WAIS performance by elderly Ss (Berkowitz, 1953; Botwinick & Birren, 1951, 1963; Chesrow, Wosika, & Reinitz, 1949; Doppelt & Wallace, 1955; Eisdorfer & Cohen, 1961; Fox & Birren, 1950; Madonick & Solomon, 1947; Norman & Daley, 1959; Rabin, 1945). DSy ranked as the lowest subtest among these Ss, with an average subtest ranking of 10.85 out of 11 subtests as computed by Botwinick. Thus, among elderly Ss, DSy is most often the lowest subtest. This finding was obtained whether the sample consisted of all females, all males, or both males and females. As in the case of brain damage (e.g. Morrow & Mark, 1955), the DSy decrement is rather considerable. For example, Fox and Birren (1950) found that for 50 male and female Ss with a mean I.Q. of 101, the mean WB DSy scale score was only 5.02, approximately half of what it would be among young adults.

In attempting to explain the effects of aging upon WB and WAIS performance, Geist (1968) discussed numerous factors which shed light on the decrements obtained in old age samples. Those which seem to be most relevant to DSy performance are: motivation, sensory deficits, educational factors, speed, and "psychometric" (criterion) problems. In short, the elderly S may not be motivated to try hard or to work quickly; he may be handicapped by sensory rather than intellectual deficits; he is at a disadvantage on tests which predict academic achievement rather than life achievements because he has not been in school for years; his life style is oriented toward caution and deliberateness, so that he is handicapped by tests which demand speedy, almost impulsive, responses; and finally, he is confronted by tests which measure very limited aspects of intelligent functioning, thus neglecting his capacity for creativity, originality, and high level judgments.

Geist's (1968) arguments strongly implied that these and other factors unfairly penalized the oldster, the implication apparently being that these factors are not intellectual ones and therefore should not be given weight in scales purported to measure intelligence. Wechsler (1958), however, has argued convincingly that the DSy deficit in particular is fully appropriate inasmuch as it reflects the elderly _S_'s actual level of functioning in realistic situations where mental speed as well as intellectual power are required.

Interpreting DSy as a measure of the capacity to do work (Wachtel & Blatt, 1965), the decrement in DSy performance in senescence may be directly proportionate to the old person's decreased ability to work. While compulsory retirement at age 65 may not be appropriate in most fields of employment, the frequency with which this criterion is employed in industry suggests that the elderly in most occupations have demonstrated a decreased capacity to do work properly. If there were a reliable relationship between DSy score and the ability to continue working in old age, the DSy Test could become one important test in a test battery designed to assess the capacity of the elderly to continue working past the somewhat arbitrary compulsory retirement age limits. Many oldsters are undoubtedly forced to retire while they are still highly capable merely because the average old person may be relatively unproductive and risky to employ.

Leaders in industry may well realize that their compulsory retirement regulations are somewhat arbitrary and may result in a premature loss of some skilled employees, but they may be motivated to enforce such regulations because of the conclusion that most of their elderly employees are relatively unproductive, unreliable, and accident prone after the age of, perhaps 60 or 65. If business leaders could objectively and fairly determine which elderly employees are capable of effectively continuing their work performance, they might well prefer to retain them. Nor should labor unions object if capable employees were also given the option of retiring with full benefits anyway, and if determination of continuing employability were based on valid and impartial evidence. While the use of DSy alone would probably be inadequate as the sole criterion of employability in any occupation, the validation of it as a measure of the capacity to do work would warrant its inclusion in any battery of tests used to distinguish the employable aged from the unemployable. To the author's knowledge, however, no data are yet available directly concerning the relationship between DSy performance and work criteria in old age.

Inasmuch as DSy ability declines in organicity and conditions of functional psychopathology as well as in senescence, the question arises whether the decrement in DSy due to age is basically of the same nature as the decrement in DSy due to psychopathology. Is the same factor involved in both senescence and psychopathology? Intuitively, it is possible to see some similarity between senescence and brain damage. Deficits in memory, perception, orientation, and cognition may be present in both conditions. In fact, senescence itself is associated with gradual physical deterioration, neurology not excluded. Since senility overlaps with organicity, it is to be expected that they both would result in some of the same deficits. Functional psychopathology may also have factors in common with some cases of senescence, including the factors listed above for organicity. One thing that all these conditions share is a general state of maladaptive functioning, inefficiency, and unproductiveness. Unless he is rehabilitated, the severely brain damaged or emotionally disturbed patient is just as ineffective, unproductive, and unemployable as the senile senior citizen. They all share in common the relative inability to do work.

It was noted years ago that the Wechsler subtest pattern in old age has many similarities to the subtest pattern in schizophrenia (Margaret, 1942; Olch, 1948). Also, Berger, et al., (1964) found that on the quasi-specific DSy factor, there was considerable factorial similarity between the chronic schizophrenic and brain damaged samples, but not between these and the neurotic group. Age produced greater factorial dissimilarity than psychopathology. Recall Cohen's (1957) conclusion that the key factors in DSy performance apparently change in the transition from youth to senescence. Botwinick and Birren (1951) reported that among the Wechsler subtests, DSy was among the least differentiating between psychotic and nonpsychotic elderly Ss. Was this due to a similarity in the underlying processes which resulted in both DSy decrements and which are present in both psychoses and senescence? The explanation for similar DSy deficits in different pathological conditions has not been adequately formulated and remains a problem, but whatever the answer may be, it seems likely that inefficient energy expenditure, the relative inability to do work, or similar DSy constructs will be of central importance. For example, it may be that efficient energy deployment is commonly present in youth and in neurotic conditions where the patient's symptoms may be fairly specific and restricted, so that differences in DSy performance among such Ss may be due to other cognitive factors. However, among such patients as chronic schizophrenics and organics, the capacity for efficient energy expenditure is more rare and thus of factorial and diagnostic significance.

Educational deprivation. Closely associated with the age variable are variables such as level of education and the number of years since completing formal education. Thus, besides being an important condition in itself, education deprivation is a potentially serious confound in the above discussion of DSy and senescence.

Assuming that education tends to enhance one's intellectual capacities, well educated people should perform better on intelligence tests than people with relatively less education. This relationship between level of education and intelligence test performance has been confirmed repeatedly. For example, the WAIS standardization sample (Wechsler, 1958) of 200 eighteen and nineteen year olds yielded a correlation of .688 between total score and level of education. For the 300 *Ss* ranging in age from 45 to 54 years, this correlation rose to .718. For the 18 to 19 year old group, DSy by itself correlated .609 with level of education, falling to .586 in the 45 to 54 year old group. In its relationship with level of education, DSy was consistently superior to all other performance subtests as well as some of the verbal ones. This would suggest that *Ss* who have had less education will do more poorly on DSy. That is, DSy apparently can measure degree of educational deprivation.

For children, age is positively correlated with DSy (Coding) performance. Apparently, DSy ability increases during the same years that level of education ordinarily increases, and then decreases with advancing age, when the recency of formal education ordinarily decreases. This correlation of age, education, and DSy performance makes it extremely difficult to assess the effect of age independent of education.

Thus, the effect of education is usually confounded with the effect of senescence on DSy. Anastasi (1968) has recently given great emphasis to this point, explaining as follows (p. 292):

> Because of the rising educational level of the general population, older groups at any one time will have received less education than younger groups.... Cross-sectional studies of adult intelligence, in which persons of different ages are tested simultaneously, are likely to show an apparent age decrement because their results are confounded with cultural changes. Longitudinal studies, based on retests of the same persons over periods of 5 to 40 years, have generally shown the opposite trend, the scores tending to improve with age.

Birren and Morrison (1961) have suggested that at least one "incremental factor" and one "decremental factor" are simultaneously operative in the aging process. That is, the experience of the elderly S tends to increase his ability on tests such as Vocabulary and Information, which are affected by achievement, whereas the physical decrements associated with old age tend to decrease his ability in certain sensory and perceptual functions.

On the one hand, the old person fares better in longitudinal than in cross-sectional studies, and on the other hand, he experiences improvement with age on some subtests and decrements on others.

On the DSy Test in particular, the elderly tend to do quite poorly, as was concluded in the section on DSy and senescence. But most of the evidence for this conclusion was based on cross-sectional studies, those which tested the elderly at only one point in time, with the effect of education left uncontrolled. Is the decrement in DSy performance obtained also in longitudinal studies where the effect of education can be better assessed? Apparently, the DSy decrement in advanced age occurs also in longitudinal studies (Jarvik, Kallmann, & Falek, 1962) but it tends to be greatly reduced (Granick & Friedman, 1967).

A different approach to assessing the relative effects of education and old age was employed by Birren and Morrison (1961). These authors factor analyzed the WAIS standardization data of 933 _S_s, ranging in age from 25 to 64. What was novel about their approach was that they included age and education as "scores" in the correlational matrix. The results indicated that DSy scores correlated .57 with level of education and -.46 with age. With education held constant, the correlation between DSy and age was -.38. Thus, it appears that the decrement in DSy with advancing age is only partly an artifact of educational differences. Note that the correlation between DSy and age dropped only a little when education was held constant, from -.46 to -.38. Birren and Morrison (1961) also found in this study that level of education and the "g" factor correlated .29, while the correlations between the individual subtests and "g" ranged from .24 for Digit Span to .32 for Vocabulary and Information. The correlation between DSy and "g" was .28, but was reduced to .23 with education held constant. In conclusion, it appears that while age and level of education are often confounded in research, both are independently related to DSy performance in addition to sharing some DSy variance in common.

Granted then, that DSy is positively related to level of education as such, how does this occur? In attempting to account for the relationship between DSy and senescence, factors such as decreased motivation, sensory deficits, educational factors, speed, and criterion problems were considered. It might be helpful to see if any of these factors also apply to the relationship between DSy and level of education. Of all these factors, the probable effect of motivation on both DSy and educational advancement is most striking. Consider the nature of educational advancement. Besides requiring a minimum level of intelligence, college advancement for example requires a very high level of achievement motivation (Dulin, 1968). Consider also the nature of the DSy task. It also requires both intelligence (Wechsler, 1958) and motivation (Glasser & Zimmerman, 1967; Oakland, 1969). As Wachtel and Blatt (1965) have shown, DSy score is largely a function of how much energy can be efficiently applied to the task. While efficiency is emphasized, implicit is the assumption of the S's motivation to apply some degree of energy. Thus, in the previous discussion of implicit decisions which face the S, it appeared that the most fundamental private question for the S to answer is, in effect, "How hard should I try?" DSy does not require complex problem solving or abstractions. Primarily, it requires concentrated effort or plain, old "hard work." As any average college student knows, this is also what it takes for him to advance to the next year level. Thus, successful DSy performance and educational advancement both share at least two important components, intelligence and motivation.

Another clue to understanding the relationship between DSy and level of education can be found in the previous discussion of the relationship between DSy and reading disabilities. In reading disabilities, such factors as visual deficits, mixed cerebral dominance, brain damage, inadequate instruction, poor motivation, and emotional problems may have causal significance (Kessler, 1966). These same factors would tend to result not only in school failure through reading disability, but also by directly affecting all other channels of learning. Similarly, the inefficiency which impairs school performance and contributes to underachievement also tends to result in grade failures, demotions, and limited educational advancement. The same factors which apparently contribute to reading disability, underachievement failures, and subsequently limited educational advancement also seem to contribute to decrements in DSy. In summary, underachievement, reading disability, organicity, and emotional disturbance, as well as deficits in motivation and intelligence would all contribute to decrements in DSy as well as seriously restricting educational advancement. These factors help to account for the hypothesized relationship between decrements in DSy and educational deprivation.

Susceptibility to anxiety and stress. Extreme susceptibility to anxiety and stress is a characteristic of the maladjusted person, and can be considered a condition of behavioral inefficiency. However, even the well adjusted person may function less effectively when he is under stress or experiencing anxiety. Within the normal population, people vary in how well they perform in the face of stressful situations and how much anxiety they can tolerate without it having a detrimental effect. From this point of view, it might be hypothesized that anxiety is inversely related to DSy performance, with low anxiety Ss doing best and high anxiety Ss doing worst. Clinically, this assumption is made when a relatively low DSy score is interpreted as a sign of anxiety. Thus, Wechsler (1958) listed DSy, along with Arithmetic and Digit Span, as being among the subtests most detrimentally affected by anxiety.

According to drive theory (Taylor, 1956), however, performance should be a complex function of anxiety level and task complexity. Thus, the higher the anxiety-drive level within the normal range, the better the _S_ will perform in a simple task; but in a complex task, where there are more competing responses, higher anxiety-drive levels should lead to inefficient, impaired performance. Throughout the DSy literature, DSy is most often referred to as a test of perceptual-motor speed. In this context, its simplicity is repeatedly stressed, explicitly or implicitly. As a simple task, therefore, DSy performance presumably should be enhanced by anxiety-drive, at least if it really is a simple rather than a complex task. However, a complex task may not only be more difficult, but also more threatening (Sarason, 1960), and it may be that anxiety also interacts with stress just as with task complexity. Thus, drive theory would predict that high anxiety would enhance performance under nonstressful conditions but interfere with it under stressful conditions. To the extent that the implicit speed instructions of the DSy Test constitute a stress, high levels of anxiety should produce deficits in DSy performance. Since what is "stressful" or drive enhancing to some _Ss_ may not be so for other _Ss_, the effect of anxiety on DSy is hazardous to predict from this point of view. If the standard DSy administration is not particularly stressful for most unimpaired Ss (those who are behaviorally efficient) then increasing anxiety, within the normal range, should enhance DSy performance. However, those Ss who are handicapped by some condition of behavioral inefficiency (e.g. emotional disturbance, brain damage, abnormally high or maladaptive anxiety), will tend to do more poorly under stress or high levels of anxiety. Considering the effect of anxiety alone, a curvilinear relationship can be hypothesized (Matarazzo & Phillips, 1955), between anxiety and DSy performance, with increasing level of anxiety enhancing DSy performance until the anxiety becomes so high as to approach a condition of behavioral inefficiency. at this point, further increases in anxiety may result in DSy decrements.

Another framework for predicting the effect of anxiety on DSy can be based on the observation (Sarason, 1960) that a high anxiety score on tests like Taylor's (1956) Manifest Anxiety Scale (MAS) can result from a S's ruminative, obsessive thinking about himself in response to the test items. Sarason (1960) cited evidence (Brackbill & Little, 1954; Deese, Lazarus, & Keenan, 1953; Eriksen & Davids, 1955) that (Sarason, 1960, p. 410) "the Psychastenia, Pt, scale of the MMPI, correlates as highly with the MAS as the MAS correlates with itself...." There is some item overlap between the Pt and MAS scales, and the obsessive-compulsiveness reflected in the Pt scale includes an anxiety component which is appropriately reflected in this overlap. As Sarason (1960) suggested, however, it is unlikely that this alone accounts for the high correlation between the MAS and Pt scales. The obsessive-compulsive will tend to obsess over each item of the test, attributing most anxiety items as descriptive of himself. If he ruminates over each item long enough, he inevitably recalls some instances in his life which, rigidly interpreted, make the anxiety item descriptive of himself.

Whereas _Ss_ with obsessive-compulsive tendencies apparently obtain high anxiety scores, they may also obtain relatively low DSy scores. This hypothesis arises from the observations that many researchers have made of the inefficiency of the obsessive-compulsive approach to the DSy task (Rapaport, et al., 1945; Glasser & Zimmerman, 1967; Payne, 1961). Inasmuch as the DSy score depends primarily on the quantitative aspect of performance rather than the qualitative, the overly cautious, laborious, even perfectionistic performance of the compulsive would tend to result in relatively few completed items and hence a low DSy score. From this point of view, the same _S_ who is likely to score highly on the MAS type of anxiety measure is likely to score poorly on the DSy Test.

In summary, at least three different basic predictions can be made concerning the effect of anxiety on DSy performance:

(a) To the extent that anxiety scales measure psychopathology and maladaptive behavior which therefore produce inefficient performance of the DSy task, anxiety should be negatively related to DSy score. (b) To the extent that anxiety scales reflect the drive level of the S, anxiety should interact with stress and task complexity. (c) Finally, to the extent that anxiety scales measure obsessive-compulsiveness, anxiety should be negatively related to DSy score. Each one of these hypotheses is made under the assumption that intellectual ability is held constant, but this reservation is particularly relevant to the factor of obsessive-compulsiveness, which is often associated with intellectual superiority. Therefore, the absolute level of DSy score among obsessive-compulsives may not be low because of their general intellectual superiority, but the position of DSy relative to the other subtests should still be low, according to this rationale. To further complicate prediction, many of the above variables and others not yet discussed could result in complex, higher order, interactions in determining the effect of anxiety and stress on DSy performance. Thus, if all of these assumptions are accepted in one theory of DSy performance, almost any result could be "explained"—hardly a desirable characteristic of a theory, which to be useful must be testable. At this point, it is necessary to consider the research on the effect of anxiety, drive, and stress on DSy performance in order to see which of the theoretical positions are most consistent with the data.

The effect of anxiety and stress upon performance has been a popular topic of research for the last two decades. As the sample of studies represented in Tables 1 and 2 suggests, DSy has often been employed as a performance measure in this research. The exceptional popularity of DSy for this purpose may in part be due to its apparent sensitivity to varying levels of drive, its superficial simplicity, its ease of administration and scoring, and its use in clinical psychology as an inverse measure of anxiety. Whatever the reasons for its use, however, it should be noted, to begin with, that in most of these studies, it was the effect of anxiety and stress on performance in general that was of interest to the investigators, not the effect of these variables on the DSy Test as such. That is, these experiments generally were construct oriented, rather than test oriented as in the present study of the DSy Test.

Consequently, the authors of these studies often chose to modify the DSy Test in order to improve its psychometric characteristics or make it more relevant to their theoretical interests. These modifications included: extending the time limit and the number of items, adapting the test for group administration, and varying the complexity and difficulty of

TABLE 1

A Summary of Representative Studies of the Effect of Anxiety on DSy Performance

Study	Anxiety Measure	DSy Measure	Results
Beck, et al., 1962	Ratings	Extended WAIS DSy	No Difference
Boor & Schill, 1967	MAS[a]	Group WAIS DSy 4 90 second trials	Anxiety X Defensiveness, $p < .05$
Burger, 1963	PRS[b]	Extended Simple DSy Extended Complex DSy	No Difference No Difference
Goodstein & Farber, 1957	MAS	Extended WB DSy	No Difference
Johnson & Cross, 1962	MAS	Unspecified DSy, Easy, Difficult, & Control	No Difference
Mandler & Sarason, 1952	TAS[c]	WB DSy, 12 60 second trials	No Difference
Matarazzo, 1955	MAS	WB DSy	No Difference
Matarazzo & Phillips, 1955	MAS	Extended WB DSy	High > Low, $p < .03$, and Tendency to Curviliniarity
Paul, 1967	MAS	WAIS DSy	No Difference
Rapaport, et al., 1945	Ratings	WB DSy	High > Low, $p < .05$
Sarason, et al., 1952	TAS	Modified WB DSy, 5 50 second trials	Stress X TAS Trial 1, $p < .001$ Trial 5, $p < .05$

TABLE 1—Continued

Study	Anxiety Measure	DSy Measure	Results
Sarason & Minard, 1962	TAS	WAIS DSy	TAS X Sex X Stress, $p < .05$
Sarason & Palola, 1960	TAS BMAS[d]	Modified, Group WB DSy, Difficult & Easy	TAS X Difficult, $p < .025$ TAS X Difficult, X Stress, $p < .01$
Siegman, 1956	MAS	WAIS DSy	No Difference
Wachtel & Blatt, 1965	FMAS[e]	WAIS DSy DSy Improvement	No Difference Low FMAS > High FMAS, $p < .05$
Weiss, Katkin, & Rubin, 1968	Death & Illness Anxiety Scale	WB DSy Motor Errors Perceptual Errors	Stress X Anxiety, $p < .05$ No Difference
Westrope, 1953	MAS	Extended WB DSy	No Difference
Wittenborn & Holzberg, 1951	Ratings	WB DSy	No Difference

[a] Manifest Anxiety Scale (Taylor, 1953)

[b] Personal Reaction Schedule (Nicolay, Walker, & Riedel, 1966)

[c] Test Anxiety Scale (Mandler & Sarason, 1952)

[d] Bendig Manifest Anxiety Scale (Bendig, 1956)

[e] Freeman Manifest Anxiety Scale (Freeman, 1953)

TABLE 2

A Summary of Representative Studies of the Effect of Stress on DSy Performance

Study	Stress Variable	DSy Measure	Results
Burger, 1963	Unobtainable Norms	Extended Simple DSy Extended Complex DSy	Stress > Non-Stress, $p < .01$ No Difference
Gallaher, 1964	Vocabulary Failure Report	WAIS DSy	Stress>Non-Stress, $p < .05$
Lazarus & Erikson, 1952	Failure Report, "one more chance," and false norms.	Extended Group WB DSy Improvement	Achievement X Stress, $p < .01$
Mandler & Sarason, 1952	DSy Failure Report	WB DSy, 12 60 second trials	No Difference
Paul, 1967	Suggestion of Anxiety Effects	WAIS DSy	No Difference
Sarason, et al., 1952	Unobtainable Norms	Modified WB DSy, 5 50 second trials	No Difference
Sarason & Minard, 1962	Achievement Orienting Instructions	WAIS DSy	Stress X TAS X Sex, $p < .05$
Sarason & Palola, 1960	Ego Involvement	Modified Group WB DSy, Difficult & Easy	Stress X TAS X Difficulty, $p < .05$

TABLE 2—Continued

Study	Stress Variable	DSy Measure	Results
Sherman & Blatt, 1968	Failure, and "Make up for it" instructions	WAIS DSy	Stress > Non-Stress, $p < .05$ No Difference
Solkoff, 1964	Frustration	WISC Coding	Non-frustrated > Frustrated, $p < .05$
Solkoff & Chrisien, 1963	Frustration	WISC Coding	Non-frustrated > Frustrated, $p < .05$
Weiss, et al., 1968	Death & Illness Film	WB DSy Motor Errors; Perceptual Errors	Stress X Anxiety, $p < .05$; No Difference
Westrope, 1953	Electric Shock	Extended WB DSy, Repeated trials	Non-Stress > Stress, $p < .001$

the test by modifying the number of symbols or the shape of the symbols themselves. Another departure from the standard forms of the test (WB, WAIS, WISC) was to use any number of "warm-up" trials in order to bring DSy performance to an asymptopic level before introducing a stress or to use numerous learning trials to obtain a progression of performance scores. Where the investigator's interest is in the assessment utility of the DSy Test as it is administered in the WAIS, WB, or WISC, these departures from standard procedure and form constitute serious limitations in the applicability of the research findings. Modifications of the DSy Test are likely to change the nature of the task and the _S_ characteristics which are reflected in various levels of performance. For example, extending the time limit and the number of items is not only likely to have the advantageous effect of increasing the range of scores, it also will tend to increase the importance of learning as opposed to efficiency of performance. Where, for research purposes, it was desirable to extend the upper limit of DSy scores so as to avoid a ceiling effect, it would have been preferable to modify the scoring instead of the nature of the test itself. Thus, an alternative to increasing the number of items or the length of the test time limit would have been to give the _S_ additional points for finishing within the time limit. A proposed procedure of this type is elaborated in Chapter III.

In spite of these limitations, the numerous studies listed in Tables 1 and 2 help to clarify the effect of anxiety and stress on DSy. If not completely exhaustive, the studies listed constitute a highly representative sample. Of the 18 studies listed in Table 1, only one (Rapaport, et al., 1945) reported a significant simple effect of anxiety throughout the entire range of anxiety scores obtained. Among a group of normal control Ss, Rapaport, Gill, and Schafer (1945) found that anxious normals did better on the standard WB DSy than nonanxious normals ($p < .05$), with anxiety ratings based on interview and case history data. Using an extended form of the WB DSy, Matarazzo and Phillips (1955) confirmed this finding ($p < .03$) in the low to moderate range of MAS scores (1-15), but found that increments in MAS beyond this range tended to result in DSy decrements, thus approaching a curvilinear distribution. Adding a more extreme group of MAS scores in order to assess the possibility of the curvilinear relationship suggested by Matarazzo and Phillips (1955), Goodstein and Farber (1957) found no relationship between DSy and anxiety, curvilinear or otherwise. No differences in WAIS DSy performance due to anxiety were obtained before or after a failure report by Wachtel and Blatt (1965). However, improvement in DSy score following the failure report was greater for Ss with lower anxiety ($p < .05$). In Table 1 this is listed as a simple effect rather than an interaction because all Ss received the failure report.

While most researchers obtained no anxiety effects of any kind on DSy (Beck, et al., 1962; Burger, 1963; Goodstein & Farber, 1957; Johnson & Cross, 1962; Mandler & Sarason, 1952; Matarazzo, 1955; Paul, 1967; Siegman, 1956; Westrope, 1953; Wittenborn & Holzberg, 1951), several found significant two-way interactions between anxiety and stress manipulations such as: (a) providing the Ss with unobtainable norms so as to provoke a failure experience (Sarason, Mandler, & Craighill, 1952), (b) making the DSy task more difficult (Sarason & Palola, 1960), and (c) showing a "death and illness" film to Ss who were anxious about death and illness (Weiss, Katkin, & Rubin, 1968). The general finding in these studies was as follows: Whereas high anxiety Ss perform as well (Weiss, et al., 1968) or better (Sarason & Palola, 1960) than low anxiety Ss under low stress conditions, low anxiety Ss perform as well (Sarason & Palola, 1960) or better (Sarason, Mandler & Craighill, 1952; Weiss, et al., 1968) than high anxiety Ss under high stress conditions.

Using achievement orienting instructions as a stress condition, Sarason and Minard (1962) found that the effect of the stress depended not only on the anxiety but also the sex of the S. Females high in test anxiety did best under neutral instructions, while males high in test anxiety did best under the influence of the achievement orienting instructions. Sarason and Palola (1960) found that Ss high in test anxiety did better on DSy than Ss low in test anxiety if the DSy task was made difficult and the instructions were not especially ego-involving. This advantage was lost when the instructions were more ego-involving, however.

In summary, it seems that anxiety level in itself does not produce any significant over-all group differences in DSy performance, but in conjunction with stress variables, it can often be a significant factor. The term "stress" has been used rather loosely in this context and embraces both those factors which are primarily disruptive in nature as well as those which are primarily motivational. For example, showing a "death and illness" film to Ss who are anxious about death and illness (Weiss, et al., 1968) is essentially a disruptive procedure. However, giving Ss ego involving instructions (e.g. Sarason & Palola, 1960) or leading Ss to believe they are not doing well (e.g. Sarason, Mandler, & Craighill, 1952) may not only stimulate anxiety but also increase motivation and subsequent effort. The motivation may also become disruptive in aggravating the already anxious condition of the high anxiety S, but in itself, it may facilitate DSy performance. This distinction between types of "stress" conditions is even more relevant in studies where anxiety is experimentally induced rather than assumed on the basis of anxiety tests.

Thirteen such studies are listed in Table 2. In contrast to the studies listed in Table 1, most of them reported at least one significant relationship involving anxiety producing conditions and DSy performance. While the studies listed in Table 2 are listed together for convenience, it is well to evaluate each "stress variable" or "anxiety arousing condition" as an individual, phenomenologically distinct variable. For example, if all the anxiety arousing or stress conditions are considered together, two studies (Gallaher, 1964; Sherman & Blatt, 1968) indicate that DSy performance is enhanced by stress and three other studies indicate that it is depressed by stress (Solkoff, 1964; Solkoff & Chrisien, 1963; Westrope, 1953). Two studies indicated no differences (Mandler & Sarason, 1952; Paul, 1967) and six studies resulted in significant interactions between stress conditions and DSy complexity (Burger, 1963), anxiety (Sarason, Mandler, & Craighill, 1952; Weiss, Katkin, & Rubin, 1968) and achievement (Lazarus & Erikson, 1952), and three-way interactions with test anxiety and sex (Sarason & Minard, 1962), and test anxiety and DSy difficulty (Sarason & Palola, 1960).

Analysis of these studies by the type of stress employed reveals that when DSy performance is enhanced by stress the Ss have been made to feel that they have not been doing well enough (Gallaher, 1964; Sherman & Blatt, 1968). When the simple effect of stress consists of a decrement in DSy performance, the stress has consisted of a frustration involving a loss of impending reward (Solkoff, 1964; Solkoff & Chrisien, 1963) or a punitive electrical shock (Westrope, 1953). The facilitating stress conditions were those which, in general, presented the S with a reason to try harder, without threatening him with punishment or deprivation. A similar pattern is noticeable where interactions were obtained. Knowledge of inadequate performance improved DSy performance on a simple form of the test but not on a more complex form (Burger, 1963), for high achievers, but not for low achievers (Lazarus & Erikson, 1952), and for low anxious Ss, but not for high anxious ones (Sarason & Mandler, 1952). Achievement orienting instructions facilitated DSy performance by anxious males, but neutral instructions were more facilitating for anxious females (Sarason & Minard, 1962). Ego-involving instructions removed the advantage that anxious Ss had on a difficult form of the DSy task (Sarason & Palola, 1960). Knowledge of inadequate performance and achievement or ego-involving instructions undoubtedly increase both motivation and anxiety, thus enhancing DSy performance for many subgroups (motivating anxiety) and depressing it for others (disruptive anxiety). Anxiety arousing conditions such as a "death and illness" film (Weiss, Katkin, & Rubin, 1968) appear to have no motivating effect whatsoever, but only a debilitating effect, and only in those Ss particularly prone to that type of stress.

In summary, it appears that conditions which motivate the S to expend more effort enhance DSy performance except where the task itself is made more complex or where the S is high in anxiety or low in academic achievement. Conditions which produce frustration or task irrelevant anxiety apparently impair DSy performance. Thus, the effect of so-called stress or anxiety arousing conditions on DSy performance depends upon the extent to which they motivate increased task relevant effort as opposed to unproductive, inefficient responses. DSy would appear to be particularly sensitive to increased "drive" or effort, since how fast the S works is little affected by high order intellectual processes. The S must simply work effortfully and efficiently. Increased effort enhances performance while increased inefficiency impairs it. When the single factor of "anxiety" is used to characterize both of these reactions to stress, the effect on DSy will be difficult to predict.

Whether anxiety is measured as a characteristic of the S or induced through experimental stress conditions, in itself it is a surprisingly poor predictor of DSy performance. However, when either form of the anxiety variable is varied with the other or with other significant variables, its relationship to DSy performance often becomes significant. Just as it apparently is maladjustment or psychopathology which impairs DSy performance rather than depression as such, it may be maladjustment or behavioral inefficiency rather than anxiety as such which impairs DSy performance. It is not how anxious the S feels which significantly determines his DSy score; it is what he does about it that is important. Anxiety represents a state of heightened behavioral readiness which may be used effectively or ineffectively, depending on other variables.

Handedness

Although the left-handed person may occasionally be inconvenienced by human engineering and customs designed to accomodate the right-handed majority, left-handedness is not ordinarily thought of as a behavioral inefficiency. Nevertheless, some left-handed Ss are clearly handicapped on the DSy Test. These are the so-called "crabbed" left-handers (Bonier & Hanley, 1961) who bend their wrists so as to position the pencil between themselves and their left hand. This handwriting style tends to result in the same left to right slant as obtained by the right-handed majority, but it has the distinct disadvantage of causing the hand and arm to cover the code key, which is located above the answer section of the test form. Thus, as McCarthy (1961, p. 407) has noted, these "Ss must lift their hands repeatedly during the timed performance on the WISC and WAIS record blanks thus slowing their performance and lowering their scores."

Experimental confirmation of this DSy decrement among "crabbed" left-handers was obtained by Bonier and Hanley (1961). Using small samples of male college students, these authors found a highly significant ($p < .005$) difference in WB DSy performance related to the type of writing style utilized. "Crabbed" left-handers did worse on DSy than right-handed Ss and those left-handed Ss who used a conventional style of writing. On a modified "unbiased" form of the WB DSy, no statistically significant differences were obtained. The "unbiased" modification consisted in changing the test format from a horizontal to a vertical alignment, with the S working down rather than across the page. The code key was also arranged vertically and placed on the left-hand side of the page for right-handed Ss, and on the right for left-handed Ss. This format eliminated the bias effect although a nonsignificant trend in favor of right-handed Ss remained.

In a second experiment, Bonier and Hanley (1961) tested the effectiveness of Wechsler's (1949, 1955) suggestion for minimizing this bias. Wechsler recommended that the code key from a second record form be provided for left-handed Ss. Conveniently placed, this second code key would make it unnecessary for the "crabbed" left-handed Ss to raise his hand after each item in order to see the code key on his test form.

Bonier and Hanley (1961) utilized this modified procedure with the WB DSy and found that "crabbed" left-handers continued to be inferior to left-handed Ss who employed the conventional writing style ($p < .025$). Although the modified instructions tended to ameliorate the bias slightly, the difference was still substantial. The authors suggested that Wechsler's modified procedure was ineffective because few of their Ss seemed to utilize the extra code key and "a certain amount of confusion was apparent in those who did (p. 288)." McCarthy (1961) suggested that the addition of a second record form does not eliminate the bias because "the visual distraction of the several additional lines of identical material interposed between the key and the work may complicate the process... (p. 407)." While no adequate norms are available for determining an accurate "adjustment" in the DSy score of "crabbed" left-handed Ss, the use of the extra record form and an average adjustment of five raw score points will usually be a generous correction for this bias. This is based on the data obtained by Bonier and Hanley (1961) which indicated that even with the extra record form, "crabbed" left-handers, on the average, scored 4.6 raw score units below the mean for conventional left-handed Ss. However, where the DSy criterion task involves a real life situation where the "crabbed" left-handed S might be at a comparable disadvantage, a neglect of such compensating procedures might actually increase DSy validity. For example, to the extent that achievement test performance may be similarly impaired by this so-called "artifact," the uncorrected DSy score might well be a more valid measure of "achievement" potential.

Peripherally related to the handedness variable is a study by Briggs (1960), which is included here because of the relative paucity of research in this general area. What if a S is suffering from some malfunction of his dominant hand at the time of testing? How will this effect his performance on DSy as opposed to other Wechsler subtests? Briggs (1960) found that of the four WAIS subtests requiring a motor response, DSy was the only one appreciably affected by use of the nondominant hand, with an average deficit of over three scale score points. Considering the enormous difficulty of writing with one's nondominant hand, a decrement of at least this magnitude would be expected intuitively. This "artifact" will occur rarely in the ordinary testing situation, but when it does, the question remains as to whether or not this "penalty" is appropriate. To the extent that DSy measures the S's "productivity" or "ability to do work" as opposed to abstract intellectual capacity, it may be. In other words, the person with some malfunction of his dominant hand is temporarily handicapped in his work performance, and DSy is sensitive to this handicap.

Sex Differences

A significant sex difference is often found on the DSy Test, with females clearly superior to males (Boor & Schill, 1967; Darley & Winitz, 1961; Gainer, 1962; Herman, 1968; Goodstein & Farber, 1957; Miele, 1958; Minuchin, 1963, 1964; Norman, 1953; Quereshi, 1968; Shaw, 1965; Wechsler, 1958). While Wechsler (1958) suggested that as many as eight subtests show some degree of sex bias, his data on 1700 Ss suggests that DSy is the subtest with the most clear-cut or pronounced sex difference. The critical ratio between the sexes on DSy (7.42) was the highest of all 11 WAIS subtests, followed closely by Arithmetic (7.28) and to a lesser extent Picture Completion (4.93), both of which favored males (Wechsler, 1958, p. 147).

In spite of the frequency with which the superiority of females on DSy has been reported, authors have rarely attempted to explain how this difference occurs (McCarthy, 1961). More surprisingly, this author has been unable to find even an exploratory study designed to clarify the specific nature of this phenomenon. It is as if researchers in the field are content to accept the DSy sex difference as being as basic as the anatomical differences between males and females. One reason for the apparent lack of research in this area may be the superficial simplicity of the DSy task itself. The researcher who would attempt to specify more exactly what it is that the female Ss do better on DSy is faced with the problem of finding other DSy variables which might be considered more basic than the DSy score itself. What measurable, basic aspects of DSy performance can be isolated and examined other than the final score? This is essentially the same problem which faces the diagnostician who would like to learn more from each S's DSy performance than a simple, over-all score. Although this problem may have inhibited research in this area in the past, numerous DSy variables of potential importance have already been discussed in this paper. Pencil pressure, neatness, errors, and numerous stylistic variables are now available to the resourceful researcher.

The physical difference hypothesis. Another possible reason for the apparent dearth of research into the DSy sex difference may be the appealing plausibility of implicitly attributing the difference to basic sex related physical factors such as tactile sensitivity and physical size. This is essentially the explanation implied by Gari and Scheinfeld's (1968) discussion of sex differences in perceptual-motor skills:

> The...greater tactile sensitivity of females which is already apparent at birth may contribute to their greater manual dexterity and early in life direct them toward activities which require manual skills, such as sewing, knitting, embroidery, dental laboratory work, and microscopic research in biology and biochemistry (p. 205).
>
> The female's more delicate physique and her greater tactile sensitivity are the assets contributing to

> her superior manual dexterity.... Women also excel in the perception of details which require frequent shifts of attention, such as typing, filing, checking lists for accuracy, and...other clerical skills.... Women excel in all tests of clerical speed and accuracy, with the sex difference remaining substantial even when both sexes receive equal training (pp. 254-255).

The relevance of these skills to DSy performance is readily apparent. The female's superior manual dexterity would presumably facilitate the speedy drawing of the appropriate symbols, while her special skills in perceptual speed, accuracy, and rapid shifts of attention are particularly relevant to the rapid visual activity involved in the usual approach to the DSy task. The _S_ typically must look at the digit for each test item, direct his glance to the digit in the code key, then to the associated symbol directly beneath it, and finally, back to the digit and empty square of the test item, which he fills in with the appropriate symbol. The female _S_, therefore, is especially skilled in those perceptual and motor activities which are apparently required in DSy performance. This interpretation of the DSy sex difference is not only highly plausible, but also, it is hypothesized to derive from basic physical differences such as "delicate physique" and "tactile sensitivity," which therefore would ground the DSy sex difference in basic physical causes, enhanced further by cultural factors.

Although this explanation of the DSy sex difference has not been offered explicitly in any of the studies reviewed, it would seem to follow quite directly from Gari and Scheinfeld's (1968) analysis of general perceptual-motor differences. Perhaps the other researchers in the field have implicitly assumed that the DSy sex difference is due to basic sex related physical differences, thus abandoning any attempt to search for other explanations. To repeat, however, this physical difference hypothesis apparently has not been tested. Presumably, the relevant aspects of the female's "delicate physique" (Gari & Scheinfeld, 1968) should be reflected in convenient hand measurements like ring or glove size and therefore could be readily tested. A measure of "manual dexterity" could be employed, but it might be more difficult to find a "pure" test of this factor or at least one which is conceptually and empirically established as being a more basic measure of manual dexterity than DSy itself.

An artifact of handedness. Of all the studies included in this review of the literature, only one article (McCarthy, 1961) contains an explicit attempt to explain how female *Ss* do better on DSy than males. McCarthy (1961) noted that some left-handed *Ss* are handicapped on DSy by their writing style—a finding confirmed by Bonier and Hanley (1961). Making the apparent assumption then that left-handed *Ss* as a group tend to obtain lower DSy scores as an "artifact" of handwriting style, McCarthy reasoned as follows (pp. 407-408):

> Since left-handedness and reading difficulties are known to occur much more frequently in males than in females, it is likely that the highly significant sex difference in favor of women...for the Digit-Symbol test of the WAIS can be accounted for on this basis.
>
> Thus, poor performance on the Digit-Symbol and Coding tests of the Wechsler scales is probably often an artifact.

According to this interpretation of feminine superiority in DSy performance, more males are left-handed than females and thus are unfairly handicapped by a writing style which obstructs one's view of the code key. Similarly, the relationship between DSy and reading disability is also assumed to be an "artifact" due to the great proportion of left-handers among the population of disabled readers. McCarthy offered evidence in support of her contention regarding the relationship between left-handedness and reading disability (Bennet, 1938; Benton, 1959; Monroe, 1932; Robinsion, 1946) but none for her contention regarding left-handedness and masculinity.

Assuming that there is a great enough preponderance of left-handedness among males to account for their relative disadvantage on DSy, this hypothesis would be quite plausible. Actually, McCarthy's (1961) hypothesis is not based on the disadvantage of left-handedness as such, but on the disadvantage of the "crabbed" writing technique which is apparently much more prevalent among left-handed Ss. Recall that Bonier and Hanley (1961) found that the "crabbed" writing technique, but not the conventional writing technique of left-handed Ss, was associated with lower DSy scores. More precisely, then, McCarthy's hypothesis depends on a greater preponderance of the "crabbed" writing technique among males. Informal support for this assumption was provided by Bonier and Hanley (1961). They wrote that because "the 'crabbed' technique is relatively rare in women (p. 287)," they employed male Ss only. Like the physical difference hypothesis, this "crabbed" writing explanation of the DSy subtest is both plausible and testable.

Anxiety and motoric tension reduction. Another possibly significant factor in his sex difference is anxiety or drive level. The previous review of anxiety and stress conditions suggested that as main effects, anxiety and stress were not consistently related to DSy performance, but that they often interact with each other and other variables to affect DSy. It was suggested that the inconsistent effects of anxiety and stress were due to heterogeneous aspects of each variable, some enhancing performance and some interfering with it. For example, an anxiety measure may have an enhancing drive component but also a disruptive maladjustment component. Similarly, some stress conditions may not only elicit greater efforts on the part of the S but also greater inefficiency. More importantly, some Ss may be more vulnerable to the disruptive aspects of anxiety than other Ss. That is, some Ss who are high in anxiety are well adjusted and behave efficiently, while others are less well adjusted and tend to manifest maladaptive, inefficient behavior. The *S* who is high in the drive component of anxiety but low in the maladaptive component should be able to expend considerable energy on the DSy task and channel it efficiently, thus obtaining a very superior DSy score.

For this analysis to be useful in explaining the DSy sex difference, it must be assumed that females are: (*a*) more anxious than males, and (*b*) less vulnerable to the disruptive effects of anxiety. The first assumption has been confirmed repeatedly. Females do tend to be more anxious than males, at least as measured by paper and pencil tests of anxiety (Brim, Glass, Lavin, & Goodman, 1962; Davis, 1968; Goodstein & Goldberger, 1955; Phillips, 1966; Sinick, 1956; Weickert, 1967). Furthermore, physiological measures such as heart rate (Burgess & Hokanson, 1964) also indicate that females have higher drive levels and that heart rate as such is directly related to DSy performance for both males and females.

Whether females are less vulnerable to the disruptive effects of anxiety is more difficult to determine, but some evidence suggests that for the DSy type of task in particular, females are relatively immune to the disruptive effects of anxiety, but are aided by the related high drive level. That is, they experience the advantage of anxiety without its disadvantages. This is apparent in the general finding that females score higher on anxiety scales such as the Manifest Anxiety Scale (MAS) and yet also score higher on DSy. Whether or not the same female _S_s score high on both DSy and anxiety is an important question. Although many studies have obtained both anxiety and DSy scores from female _S_s, they have not reported whether the extremely high anxiety females are also the extremely skilled DSy _S_s. Suggestive evidence to this effect comes from the study by Gaston and DeLange (1961) which suggested that the exceptionally high DSy scores from a psychiatric population were obtained by _S_s who were both female and psychotic. Although psychosis generally impairs DSy performance as the previous review of psychopathology revealed, these female psychotics were characterized by their DSy efficiency in spite of their presumably high anxiety.

As in the case of anxiety and depression, however, it is probably not the anxiety level as such that is most important. If it were, then anxiety as such should be directly related to DSy performance, but it is not. This is the perplexing problem. Why should females be higher in anxiety, which in itself does not enhance DSy performance, and yet be superior on DSy itself? The simplest answer is to assume that the two findings are both accurate but unrelated. That is, that females are higher in anxiety and higher in DSy performance, but that the anxiety has nothing to do with the DSy performance. However, the frequently obtained interaction of anxiety with other variables (Tables 1 and 2) raises the expectation that anxiety may interact with some characteristic frequently found in females. It might be guessed that this characteristic, while found at high levels in a minority of females, may raise the female average DSy score high enough to account for the sex difference.

Remember that anxiety scales like the MAS correlate very highly with the Pt scale of the MMPI which reflects obsessive-compulsiveness. It was hypothesized by Sarason (1960) that many _S_s score high on anxiety scales because they ruminate over the test items. In obsessive-compulsive fashion, they seem to find relatively minor reasons for answering most of the anxiety items as descriptive of themselves, while a less legalistic interpretation of the items might result in lower anxiety scores. Accordingly, the high anxiety scores of many females may reflect obsessive-compulsiveness and a characteristic readiness to control anxiety through obsessive-compulsive defenses.

Yet, it has been concluded that an overly compulsive, perfectionistic approach to DSy is inefficient and productive of low DSy scores. This would lead one to predict that high anxiety _S_s would do poorly on DSy. On the other hand, one way of controlling anxiety which could perhaps be considered to have an obsessive-compulsive component would be to release or channel the tension into motor activity. That being the case with females, their high levels of anxiety would be efficiently channeled into rapid, energetic DSy performance. Support for this contention comes from the observation that women have traditionally occupied themselves with repetitive manual activities such as knitting, sewing, and embroidering. In moments of tension, many women seem to work off their motor tension and control their anxieties through the rapid, repetitive, manual activity of such relaxing hobbies. To the extent that these activities, like compulsive rituals, are used to control anxiety and unexpressed impulses, they are also associated with obsessive-compulsiveness.

In summary, it is hypothesized that females score higher on the DSy Test than males because: (a) they tend to be more anxious and thus have more performance enhancing drive, and (b) they are relatively invulnerable to the disruptive effects of anxiety on the DSy Test because of their habitual use of similar manual activities as a release from tension. In other words, on the DSy Test, females experience the advantages of anxiety but not its disadvantages. Empirically, it would be predicted that those female Ss who do extremely well on the DSy Test will not only score high on general measures of anxiety, but they will score especially high in motoric expressions of anxiety.

Educational attitudes. Another potential source of the sex difference in DSy performance is educational conformity. Recall that DSy, more than any other performance subtest, is significantly related to level of education. Furthermore, females consistently obtain better scholastic grades than males, even in subjects in which males score higher on standard achievement tests (Maccoby, 1966). The American educational system, with its traditionally heavy emphasis on conformity, neatness, and "busy-work" has often been called "feminizing." Gari and Scheinfeld (1968) noted that (p. 227):

> Girls may be awarded better grades because of their greater conformity to the classroom rules and norms and their more conscientious fulfillment of class assignments, while the more rebellious and less responsible boys are apt to arouse the displeasure of the teacher.

In short, females are better acclimated to the feminized classroom routine and tend to try hard even on tasks which, at least superficially, are only repetitive "busy-work." In other words, females are conditioned to do "their homework," and in fact, tend to try hard on whatever the teacher wants them to do. This "star pupil" syndrome is much more likely to appear in females than in males. Those who more completely accept the values of the educational system learn to be competitive and to try hard on any "test." The emphasis is on conformity and attempts to please the teacher, usually a female. Thus, the more rebellious male is at an academic disadvantage.

Inasmuch as the DSy Test represents a more or less repetitive, intellectually unprovocative, and dreary task to the S, it is not likely to have the intrinsic motivation needed to interest the male S. The average female, however, will characteristically try hard regardless of the nature of the task. Since DSy primarily reflects level of motivation and efficiency of performance, the harder a S tries, the better he or she will do. Accordingly, the scholastically reinforced student, most often a female, will tend to try harder, and hence, do better on the DSy Test. In summary, females will tend to do better on DSy than males because females are better acclimated to the motivational requirements of the DSy Test.

Indirect support for this hypothesis can be drawn from a study by Minuchin (1964). Studying sex differences which may result from home and school environment, Minuchin (1964) found that the usual sex difference in favor of females on the DSy Test were obtained from students of a "traditional" school but not from students of a "modern" school. If it is assumed that the so-called "modern" schools give less encouragement to blind, authority pleasing conformity and "feminine" "busy-work" assignments, then females would not receive as much reinforcement for productive but intellectually unchallenging tasks such as DSy.

Verbal mediation. The final variable to be proposed as a causitive factor in the DSy sex difference is perhaps the most subtle of all. It is hypothesized that subvocal verbal mediation accounts for much of the variance associated with the DSy sex difference. Understanding of this factor is predicated on careful consideration of the previously discussed role of subvocal verbal mediation in DSy performance. Recall that one of the stylistic variations in approaching the DSy task consists in naming each of the symbols and then associating the name with the name of the digit. For example, upon seeing the "O" symbol when consulting the code key for the symbol to be associated with the digit "6" the S may say to himself, "capital O (is) six" or "zero (is) six." Thus, the verbal representation of the symbol is associated with the verbal representation of the digit. In other words, the subvocal verbal names for the visual symbols become associated with the names for the digits. Thus, instead of learning the visual association between "O" and "6," the S who uses subvocal verbal mediation learns the verbal association between "zero" or "capital O" and the number "six." As the S returns his glance back to the answer sheet where he will enter the symbol in the next square, he can hold the symbol in short term memory by repeatedly saying to himself the name which he assigned to the symbol until he draws it. Then he can let the symbol name drop from short term storage and replace it with a name or label for the next symbol. The S who does not use this verbal mediation, either subvocally or actually talking out loud, cannot readily rehearse the visual perception of the symbol and may often forget the symbol and use more time to remember it or to look back to the code key a second time.

The relevance of this use of subvocal verbal mediation to the DSy sex difference is due to the hypothesized tendency of female _S_s to use this approach more often and more skillfully. It is well known that females tend to excel verbally (Maccoby, 1966). Therefore, by using subvocal verbal mediation, females can take advantage of their verbal facility and obtain higher DSy scores. Males may also use this approach, but it is hypothesized that fewer males use it, and when they do, they have greater difficulty in naming the symbols quickly and appropriately.

Verbal mediation in the DSy task may also help to explain the other relationships between DSy and _S_ variables which have been discussed in this review of the literature. For example, it has been suggested (Arenberg, 1967) that any material perceived visually for short term retention is converted to auditory storage. Arenberg (1967), using a verbal learning task, hypothesized that the elderly have difficulty making this conversion. This would suggest, then, that the deficit in DSy performance among the elderly is due to their decreased ability to use subvocal verbal mediation. However, when verbal mediation is accomplished by vocalizing the material aloud, the oldster's learning and short term retention is improved (Arenberg, 1967).

Summary. In an attempt to explain the DSy sex difference in favor of females, several possible causal factors have been suggested. Summarized, they are as follows:

1. Females score higher on DSy because of sex-related physical differences such as smaller hands and fingers and greater "tactile sensitivity" which, culturally reinforced, lead to superior manual dexterity.

2. Females score higher on DSy because fewer females than males utilize the "crabbed" handed style of writing which produces DSy deficits by causing the S to cover the code key with his arm and hand (McCarthy, 1961).

3. Females score higher on DSy because: (a) they tend to be more anxious and thus have more performance enhancing drive; and (b) they are relatively invulnerable to the disruptive effects of anxiety on DSy to the extent that they habitually release their anxiety motorically, as in delicate manual tasks such as knitting, sewing, and embroidery.

4. Females score higher on DSy because, through a so-called "feminizing" educational system, they have become better acclimated to the motivational requirements of the DSy Test.

5. Females score higher on DSy because they are more verbal, and thus more likely to take advantage of a DSy

performance technique which consists of verbal mediation, usually subvocal in character.

Experimenter and Procedural Effects

In the last decade, and especially in the last four or five years, numerous reviews of the literature have focused on the importance of experimenter (E) and procedural variables in behavioral research and psychological testing (Kintz, Delprato, Mettee, Pearsons, & Schappe, 1967; Masling, 1960, 1966; McGuigan, 1963; Rosenthal, 1966, 1967; Sattler & Theye, 1967). Researchers in this area frequently have demonstrated that different Es and psychological examiners tend to obtain significantly different results from equivalent groups of Ss. However, the type of task variable utilized apparently is important in determining whether or not the E or procedural variable affects performance. For example, the numerous studies conducted by Rosenthal (1966) and his associates almost invariably employed a person perception task requiring the S to rate a person's "success" from a photograph. In this rather ambiguous and highly subjective task, E effects have been found repeatedly. However, where the dependent variable has been some standardized intellectual criterion, E effects have not always been found. For example, on the Wechsler scales, E effects have often failed to manifest themselves (Murdy, 1962; Nichols, 1959).

When E effects have been found in the Wechsler scales, DSy is often among the subtests affected. In a well controlled study, Henning (1965) employed seven male Es who administered the WAIS to 196 male institutionalized delinquents, and found significant E effects on Full Scale and Verbal I.Q. and on six subtests: Comprehension, Arithmetic, Similarities, Digit Span, DSy, and Picture Completion. Henning suggested that the clinician using the WAIS as a diagnostic instrument must consider these E effects, "lest he diagnose the examiner rather than the subject (p. 27)."

Even when no E effect is apparent in the group statistics, an interaction between the E variable and some S variable is often found on the DSy Test (Egeland, 1967; Katz, Roberts, & Robinson, 1965; Quereshi, 1968). This propensity for interactions on DSy was earlier seen in reviewing the effect of anxiety and stress on the DSy Test. Like anxiety, E effects seem more potent in interaction with S variables, but may often be obscured in designs which do not provide for assessment of interactions.

Inasmuch as both E variables and S anxiety both tend to interact significantly with other variables on the DSy Test, it is not surprising that they also interact with each other (Egeland, 1967). Although Egeland (1967) found significant E effects on the WISC Comprehension, Similarities, and Vocabulary subtests, he did not find any on the Coding (DSy) subtest. However, a significant interaction ($p < .025$) was found between

E anxiety and S anxiety. Highly anxious (MAS) Ss were superior on DSy when tested by a highly anxious E, while Ss with low levels of anxiety did best when tested by an E with a low level of anxiety. Interpretation of this finding must be tempered by the limitation that only two Es were used, so that the Es might have differed in many respects other than anxiety. At the least, however, it does demonstrate a true interaction between an E variable and S anxiety.

A similar interaction was found by Quereshi (1968) on the WISC Coding subtest, this time involving the sex of both the S and the E. A significant main effect of E sex was found for Verbal I.Q. and three subtests: Comprehension and Vocabulary as in Egeland's (1967) study, and Picture Completion. Although there was no significant main effect of E sex on the Coding subtest, there was a significant interaction ($p < .01$) involving the sex of the Ss and the sex of the Es. Girls were clearly superior to boys on Coding, but this superiority was enhanced when the S was tested by a male E. As in Egeland's (1967) study, a limited sample of Es makes the specific interpretation of the E effect hazardous. Although three female Es were employed, only one male E was used. Accordingly, the E effect could have been due to some other way in which the male E differed from the three female Es other than in sex.

Katz, Roberts, and Robinson (1965) obtained a complex interaction on the DSy task involving the race of E, task difficulty, and introduction of the DSy task as a measure of intelligence on the one hand, and as a measure of eye-hand coordination on the other. On the most difficult form of the task, Southern male Negro college students did better when tested by a white _E_, but only when the DSy task was described as a test of eye-hand coordination. This advantage did not appear when the task was described as a test of intelligence.

An exploratory study conducted by Crow (1964) and reported by Rosenthal (1966) assessed the effects of an _E_'s warmth or coldness in relating to the _S_, as well as the effect of whether the _S_ characteristically expected an "experimenter" to be warm or cold. Performance of the _S_s on a "home made version" of DSy was enhanced by warm _E_ behavior but not by the _S_'s prior expectation of _E_s as warm persons. On "spool packing" and letter cancellation tasks, however, it was the _S_'s prior expectation of warmth rather than the _E_'s warm behavior that tended to enhance performance. Limitations in sample size and in the statistical standards characteristically applied by Rosenthal and his colleagues make these findings highly tentative, however.

While it has been demonstrated that _E_ effects do occur in a variety of tasks, including the DSy Test, little progress has been made in determining how they occur. One approach has been to correlate observed behavioral _E_ variables with the degree of biasing which results (Rosenthal, 1967; Rosenthal, Fode, Friedman, & Vikan, 1960; Rosenthal, Kohn, Greenfield, & Carota, 1966). For example, in a study of E expectancy effects on a person perception task (Rosenthal, et al., 1960), it was found that those Ss who were most likely to obtain the results which they expect tended to be judged as more interested, slow-speaking, and given to the use of hand gestures than other Es. It is as if these Es were more persuasive, but it is nevertheless unclear how the Ss knew what they were being persuaded to do, to judge the persons as successful or unsuccessful. No apparent behavior on the part of the Es provided such cues.

When the E effect occurs on ability tasks like the Wechsler scales, it is somewhat easier to see how the E can affect a S's score. One way is to be more or less generous in applying scoring standards to the S's performance. It has often been shown, for example, that the scoring of some subtests such as Comprehension, varies considerably among expert Es (Plumb & Charles, 1955; Schwartz, 1966; Walker, Hunt, & Schwartz, 1965). This makes it possible for Es to be systematically lenient or strict in applying scoring criteria to ambiguous and borderline responses. Using the WB Information, Comprehension, and Similarities subtests, Masling (1959) found that Es scored responses more leniently if the Ss related to them in a warm, friendly way.

Masling (1959) also demonstrated that besides scoring responses with a systematic bias for all or only certain Ss, Es can affect the Wechsler scores by directly influencing the S's performance. His 11 Es tended to use more reinforcing comments with warm, friendly Ss and gave them greater opportunity to clarify or correct responses, compared to the cold, unfriendly Ss. Obviously, the possibilities for giving subtle advantages to some or all Ss without consciously realizing it are numerous. Small differences in timing on timed tests, subtle differences in the helpfulness of so-called "nondirective" questioning on ambiguous responses, differences in interpersonal encouragement or quality of rapport, inadvertent cues as to the adequateness of responses, and many other factors may cause some Es to obtain inappropriately high or low scores from their Ss in general or differentially for different types of Ss. Additionally, even when Es do not differ importantly in these procedural or interpersonal behaviors, Ss simply may be affected differently by Es with different appearances, personality traits, and other test-independent characteristics.

It seems likely, however, that many of the E effects seen on tests like the WAIS and WISC involve some testing behavior which differs among Es and which ultimately is due to differences in testing procedure, broadly defined. That is, many E effects may be due to subtle procedural differences among Es. Most often, the procedural effects given experimental attention have been relatively gross or obvious departures from standard procedure which enable the E to assess a patient's potential ability or his capacity under unrealistically ideal conditions. A typical departure from standard procedures on the WAIS or WISC involves a "testing the limits" procedure by which the E attempts to determine why the S made certain errors, what specific deficits might account for the error, or if he really "knew" the answer but failed to express it properly or perform it quickly enough.

Sattler (1969) and Theye (1970) independently reported similar data concerning a "testing the limits" or cue giving procedure on the Block Design and Picture Arrangement subtests of the WISC and WB. Sattler's (1969) report is more detailed, so his procedure is summarized here. "Cues" which were given following each failure without significantly affecting a subsequent posttest on the alternative form of the Block Design Test included showing the S how to arrange each of the following portions of the design until he achieved the correct design: (a) first row, (b) last row, (c) first column, and (d) last column. In order to determine just how much of this assistance or "limit testing" could be done before a minimally significant effect would be made on the results, even more extensive "cues" were given on Block Design and Picture Arrangement following any failure. These more radical "cues" included 50% additional time, followed by arrangement of increasingly major parts of the design or picture sequence, leaving very little for the S to do himself, such as having to complete only two out of six pictures in a Picture Arrangement sequence. These more radical "cues" significantly improved performance ($p < .05$), but the absolute differences in scaled scores between experimental and control groups was quite small.

Sattler (1969, p. 720) concluded that "alterations in standard procedures, when minor, are not likely to affect BD performance...." It is nevertheless quite possible that other types of "minor" procedural modifications would produce significant effects on Block Design as well as on other subtests.

In a major review of the WISC literature, Littell (1960, p. 146) suggested that the "possible effects of differences in the examiner's techniques of administration" have not received adequate experimental attention. While substantial violations of standard procedure have received experimental attention, research has been done only occasionally on the effects of minor variations in administration which are within the limits of the prescribed standardized procedures (Brodt & Walker, 1969; Newton, 1950). These are subtle differences in administrative technique which, so far, have implicitly been considered too minor to standardize.

Newton (1950), for example, investigated the relative effects of two techniques of administering the WB Digit Span

Test. This investigator found that a very subtle difference, lowering the pitch of voice on the last digit of each series results in higher Digit Span scores.

Similarly, but with different results, Brodt and Walker (1969) tested the effect of subtle modifications of the vocabulary instructions. These variations in the instructions did not involve any explicit deviation from the standard instructions. Instead, they consisted merely in certain comments which might be considered to be the kind of supportive and nondirective inquiry permitted by the general WISC instructions. One group of children was administered the subtest in a "routine, matter of fact manner"; one of the other conditions involved reading the child's responses aloud as they were being recorded; and the other condition involved a "permissive" and "encouraging" administration. No statistically significant differences resulted from these subtle procedural variations in WISC Vocabulary instructions.

In summary, DSy is one of the Wechsler subtests which sometimes is significantly affected by _E_ variables. It seems likely that many _E_ effects are due to subtle procedural variations in the testing techniques of _E_s, which nevertheless are consistent with the standardized instructions and procedures. Little research has been done with these very subtle procedural or stylistic differences in Wechsler test administration, but some findings (Newton, 1950) suggest that this would be a promising area of research. Apparently, DSy has not been studied from this point of view.

Assuming tentatively that E effects on the DSy Test are often due to subtle variations in administrative procedure, examination of the DSy administration should suggest some possibly significant ways in which the DSy administration can vary and yet be consistent with the standardized instructions and procedures. In the DSy subtest of the WAIS, for example, the E follows a highly standardized procedure consisting of verbal instructions and the performance of three demonstration items. The demonstration includes pointing to the appropriate digit and corresponding symbol in the code key, and then drawing the symbol in its box under the appropriate digit. Inasmuch as the E is showing the S how to do the task, he is also teaching his own individual style of DSy performance to the S. That is, if the E is very deliberate and slow in his actions, being especially careful to draw an exact reproduction of each symbol, the S may learn to do this also. Conversely, the S whose E draws the symbols quickly and less carefully may learn that excessive care and exactness in drawing the symbols is not at all necessary. Since drawing quality is relatively unimportant in the scoring of this subtest, and since the raw score is simply the number of symbols correctly filled in, a slow and careful performance will be penalized by the time limit, whereas a less careful but speedier performance will result in a higher score. Therefore, _E_s who perform the demonstration items quickly and carelessly will tend to elicit higher DSy scores than those who perform the demonstration items more slowly and carefully.

A related aspect of the _E_'s style of performing the demonstration items is the pencil pressure applied in drawing the symbols. It has been shown that excessive pencil pressure is an inefficient expenditure of energy, and results in lower DSy scores (Wachtel & Blatt, 1965). Accordingly, if the _E_ demonstrates a performance style of pressing down hard with the pencil, then the _S_ may tend to press down harder when he is tested, and therefore score more poorly because of the _E_'s style of performing DSy demonstration items. Conversely, a _S_ will tend to press lightly with his pencil if his _E_ does so on the demonstration items. This style tends to result in a rapid skimming over the surface of the record form, thus increasing the number of DSy items completed within the time limit.

Demonstration speed and pencil pressure are undoubtedly correlated positively, since it should ordinarily require more energy and time to write with high levels of pencil pressure. Nevertheless, some _S_s may press down heavily on the pencil and yet write rapidly, while others may press down lightly, but nevertheless work slowly. It is hypothesized, however, that speed and pencil pressure in the DSy demonstration items are two related sources of potential variation among Es which produce E effects on the DSy Test. Apparently, these variables have never been considered in the E literature on the DSy Test, or on other tests like Block Design and Picture Arrangement which also involve speed scores and demonstration items.

The hypothesized mechanism of this effect is one of social learning or imitation. The S observes the E's performance and then imitates it. Research (Bandura & Walters, 1963; Flanders, 1968; Mowrer, 1960) has clearly demonstrated that a great deal of human learning is accomplished by observing a given behavior and then imitating it. Miller and Dollard (1941) contended that reinforcement of successful learning trials was a necessary condition for the learning to occur, but Bandura and Walters (1963) have laid stress not on the learning trials, but on the events preceding the first testing trial. While it has been shown that imitation is facilitated by incentives, Bandura and Walters (1963) maintained that imitative behavior can be learned even without reinforcement during the training or observation period. On the DSy Test, this training and observation period would be the demonstration phase of the administration.

Flanders (1968) cited several studies which clearly indicate that observational or imitative learning does occur even in the absence of reinforcement. For example, even when no reinforcement is involved, several researchers (Angermeier, Schaul, & James, 1959; Bandura, Ross, & Ross, 1961; Berger, 1966; Kanfer & Marston, 1963) have found that target behaviors were learned better by groups exposed to a model than those not exposed to a model. The importance of these findings in relation to the DSy Test is that even if the E avoids giving subtle reinforcement to the S's behavior, it is likely that imitative learning will occur. Hence, initative learning may well be an exceedingly important process in DSy performance. Until research on this point is available, Es might well cautiously assume that their demonstration is a significant factor in the performance of their Ss. It is accordingly recommended that Es take special care not to vary the degree of pencil pressure applied nor the speed or qualitative exactness employed in performing the DSy demonstration items.

This brings the comprehensive review of the literature to a point where little more can be done in the way of reporting more research data, but where a great deal in the way of integrating the previously reported studies is needed. Furthermore, with so many old findings brought into a new focus, and with current research pointing the way toward numerous possible directions for further research into the DSy Test, the most promising and significant hypotheses must be identified and given priority in any program of research that would follow upon this review of the literature. The remainder of this chapter will be devoted to these tasks, and will culminate in the set of hypotheses which are to be investigated in the present study.

An Overview

The interpretation of DSy as a simple measure of psychomotor speed gained important support from research that confirmed DSy's validity as a measure of simple psychomotor abilities, but not its validity as a measure of associative learning (Burik, 1950; Luchins & Luchins, 1953; Murstein & Leipold, 1961). With the associative learning of digits and symbols shown to be unrelated to DSy performance, the visual-motor aspects of the task superficially appear to be the only readily identifiable processes involved. Hence, the apparent disinterest in the DSy Test relative to other Wechsler subtests (Murstein & Leipold, 1961) is not surprising.

On the other hand, the preceding review of the literature has described special relationships between DSy performance and such variables as distractibility, psychopathology, organicity, underachievement, vagrancy, susceptibility to anxiety and stress, senescence, reading disabilities, a specific type of left-handedness, and many others. How can DSy be a simple test of psychomotor speed on the one hand, and a sensitive measure of complex psychological variables on the other hand? In fact, how can DSy even be a relatively valid measure of general intelligence and an excellent measure of educational level (Wechsler, 1958) when it appears to involve merely a simple visual-motor copying process (Burik, 1950; Luchins & Luchins, 1953; Murstein & Leipold, 1961)?

These are some of the broad problems posed by the preceding review of the literature. A related problem is one which is inherent in any comprehensive collection of diverse and relatively unrelated research findings, the problem of theoretical integration. One step toward solving these problems was attempted in the context of the review itself, by showing that many of the conditions related to DSy performance could be regarded as "conditions of behavioral inefficiency." That is, whatever a person's current functioning is detrimentally affected by, be it stress, senescence, psychopathology, or whatever, the result usually involves some behavioral inefficiency or loss of productivity. DSy seems uniquely sensitive to this decreased efficiency, productivity, or output.

While other subtests reveal the S's current ability to use a variety of specific intellectual processes, DSy may be especially useful in predicting the S's current ability or readiness to channel these and other abilities into constructive tasks. Hence, DSy has been regarded as a measure of efficient energy expenditure and the ability to do work (Wachtel and Blatt, 1965). In the many conditions of behavioral inefficiency discussed, energy is often directed inefficiently and the affected person's ability to accomplish meaningful or constructive work, including general intelligence test performance, is diminished. These same conditions similarly result in inefficient or unproductive DSy performance, thus linking DSy performance to diverse psychological conditions and variables.

Verbal Mediation

As useful as the behavioral efficiency construct is, it is not entirely adequate in itself as a DSy "theory." An additional factor which may help to integrate some of the DSy data and explain its validity is verbal mediation. In the context of this study, verbal mediation refers to the verbalizing of symbol labels, vocally or subvocally, as an intermediary process between the explicit visual and motor aspects of DSy performance. It is predicted that normal, intelligent young adults will spontaneously verbalize most of the symbols from the WAIS DSy Test as they look at them and draw them during their DSy performance. Ordinarily, this verbalization process occurs on a subvocal, mental level, and therefore cannot be observed directly, which of course makes it difficult to study. However, if such a process is often involved in DSy performance, then it can be used to integrate several important research findings and help to account for DSy's validity as an intelligence test as well.

Recall, for example, that in many age groups the WAIS DSy subtest correlates more highly with the verbal scale than with the performance scale (Doppelt & Wallace, 1955; Wechsler, 1955), and that it correlates more highly with level of education than any other performance subtest and about as highly as the verbal subtests (Wechsler, 1958). In some ways, DSy seems to belong within the verbal scale rather than with the other performance subtests. One possible way to explain this would be to hypothesize some verbal component of DSy performance, such as verbal mediation. By translating the visual percepts of the symbols into verbal labels, this "visual-motor" task becomes a "visual-verbal-motor" task. This hypothesized verbal component could therefore account for DSy's similarity with the verbal subtests in correlating with level of education.

The transformation of the DSy Test into a verbal-motor task through the use of verbal mediation can also account for the DSy sex difference in favor of females (Boor & Schill, 1967; Darley & Winitz, 1961; Gainer, 1962; Herman, 1968; Goodstein & Farber, 1957; Miele, 1958; Minuchin, 1963, 1964; Norman, 1953; Quereshi, 1968; Shaw, 1965; Wechsler, 1958). Since females in our culture are well known to have superior verbal fluency (Gari & Scheinfeld, 1968), transforming DSy into a task with an important verbal component might enable females to do better than males.

Another consistent and rather dramatic finding which verbal mediation may help to explain is the very marked DSy decrement in old age (Berkowitz, 1953; Botwinick & Birren, 1951, 1963; Chesrow, Wosika, & Reinitz, 1949; Doppelt & Wallace, 1955; Eisdorfer & Cohen, 1961; Fox & Birren, 1950; Madonick & Solomon, 1947; Norman & Daley, 1959; Rabin, 1945; Wechsler, 1958). Although possible explanations of this decrement are abundant, especially in terms of the visual acuity and motor performance problems of the aged, some experts (Birren & Morrison, 1961; Welford, 1958) have suggested that processes intermediary with respect to visual perception and motor perfromance are of special significance. Verbal mediation, of course, would be exactly this type of intermediary process.

The plausibility of using verbal mediation as an explanatory construct in this context is enhanced by research which suggests that the ability to use mediation adequately diminishes markedly in old age (Arenberg, 1967; Szafran, 1953; Welford, 1958), but that experimental instructions to use vocalized mediation significantly diminishes the age deficit in digit recall experiments (Arenberg, 1967, 1968). It is hypothesized that in addition to whatever other handicaps they may have, the elderly are at a disadvantage in the DSy Test because they cannot use spontaneous verbal mediation as well as young adults can.

This interpretation of the DSy old age decrement also helps to explain why the correlation of DSy with WAIS full scale score actually increases among the elderly, the very age group which is most handicapped on the DSy Test. If DSy's validity as a measure of intelligence is enhanced by verbal components such as verbal mediation, then the hypothesized decrease in spontaneous mediation facility among the old may not only account for decrements in DSy performance but may also become a crucial factor in DSy's validity as a measure of intelligence.

That is, verbal mediation may not be as crucial a factor among young adults, who are assumed to spontaneously use verbal mediation with relative ease, but it may become more crucial among the old, who are assumed to experience more difficulty in its use. If these assumptions prove to be correct, it would follow, further, that whether an elderly S uses verbal mediation effectively would be more predictive of general intelligence and DSy performance than whether a young adult uses it effectively. This is to say that as a factor in DSy performance, verbal mediation may contribute more to DSy's loading of general intelligence among the old than among the young. Recall Cohen's (1957) conclusion that the factorial structure of DSy performance changes in old age. The increased importance of verbal mediation in old age would be compounded by the typical visual deficits of senescence, and would help to account for DSy's increased correlation with full scale score among elderly groups.

While only some of the most readily apparent uses of verbal mediation as an explanatory and integrating construct have been discussed here, its theoretical potential in this respect may prove even broader. For example, the significance of DSy performance in the numerous conditions of behavioral inefficiency discussed in this chapter could profitably be reassessed with respect to the use of verbal mediation. Interpretation of DSy as a verbal task through the use of such mediation could lead to expanded explanations of the DSy decrements in these conditions. However, the advisability of research into these broader areas will depend upon the experimental confirmation of more basic assumptions, such as the facilitating effect of verbal mediation itself.

Recently, Koestline and Dent (1969) initiated the experimental investigation of the effect of verbal mediation on the DSy Test and failed to confirm the most basic assumption made here regarding verbal mediation. They found that the use of verbal mediation, as they defined it, did not enhance DSy performance in their sample of 60 college students. It is possible, however, that their negative results were at least partly a function of a faulty understanding of the role of verbal mediation in the DSy Test, which consequently led to an inappropriate operational definition of verbal mediation.

Koestline and Dent (1969) utilized three conditions in their experiment. Following a pretest of DSy ability, one group of Ss learned appropriate verbal labels for each of the WAIS symbols; another group learned inappropriate verbal labels for each of the symbols; and a third group simply visually observed the symbols without labels until they believed they could recall the symbols. On a subsequent DSy posttest, the scores of the three groups did not differ significantly. However, the authors did not assess whether or not their Ss actually employed verbal labels during the DSy performance. For example, a S may learn a symbol-label association during the training period but not necessarily use this verbalization during the actual DSy performance. Similarly, a S may learn an association between a symbol and an inappropriate label for it, but not use this label, vocally or subvocally, while looking at the symbol and drawing it. That is, the S who is taught the paired associate connection between the "=" symbol and the verbalization "upside down T" may nevertheless say to himself "equals" when he later sees and writes the "=" symbol. The appropriate verbalization of "equals" or "equal sign" is probably well habituated and therefore more natural than the inappropriate label. Furthermore, a S who has simply learned the symbols visually, without labels, may spontaneously provide his own verbal labels and use them effectively during DSy performance. Thus, the failure of verbal mediation to enhance DSy performance in Koestline and Dent's (1969) experiment may have been due to the spontaneous use of appropriate verbal mediation regardless of the experimental condition employed.

The important difference between verbal mediation as used by Koestline and Dent (1969) and verbal mediation as defined in the present study is that the former authors manipulated verbal mediation in symbol learning, while the present author is concerned with verbal mediation in the DSy performance process itself. It is not surprising that verbal mediation in symbol learning does not enhance DSy performance, because it has repeatedly been demonstrated that learning is not important in the DSy Test (Burik, 1950; Luchins & Luchins, 1953; Murstein & Leipold, 1961), and that explicit attempts to learn the DSy associations actually tend to result in lower scores (Burik, 1950; Luchins & Luchins, 1953). This evaluation of Koestline and Dent's (1969) study suggests the conclusion that an adequate test of the effects of verbal mediation in the DSy performance process itself has not been carried out. It is the use of verbal labels in the visual-verbal-motor DSy performance sequence that is evaluated here, not the use of verbal labels in pretest symbol learning.

The present investigation is designed to eliminate the flaws of the Koestline and Dent (1969) study by employing an experimental manipulation of the actual use of verbal mediation during DSy performance, including controls for the expected use of spontaneous verbal mediation. It will also differ from Koestline and Dent's (1969) design in that the effect of verbal mediation will be assessed not only as a main effect, but as it interacts with age and sex, the other two independent variables in this study. Supporting evidence will be sought for the interpretations of the DSy sex difference and the old age deficit in terms of the verbal mediation construct, and alternative explanations of the DSy sex difference will be given preliminary, exploratory attention.

Primary Hypotheses

Specifically, the primary hypotheses to be tested are as follows:

1. Effectiveness of experimental instructions. Experimental instructions designed to affect the use of verbal mediation will affect the reported use of verbal mediation as measured by the number of symbols so mediated (Mediation Use Scale). The vocal mediation condition and the spontaneous mediation condition will each produce greater use of verbal mediation than the competing vocalization condition. These comparisons are tests of the effectiveness of the experimental instructions.

2. Facilitating effect of verbal mediation. The three different mediation conditions will result in significant differences in DSy performance. Specifically, it is expected that the vocal mediation condition and the spontaneous mediation condition will elicit higher DSy scores on the average than the competing vocalization condition. This is the test of the basic assumption that the use of verbal mediation enhances DSy performance. It is suggested by indications that DSy may have a verbal component (Wechsler, 1958) and by the effectiveness of this prediction in explaining the DSy old age deficit, the DSy sex difference, the correlation between DSy scores and level of education, the correlation between DSy scores and verbal scale scores, and other findings discussed under the "Verbal Mediation" heading of the preceding review of the literature. Additionally, there is already some literature available which has demonstrated the facilitating effect of verbal mediation in other tasks (e.g. Arenberg, 1967, 1968; Bandura, Grusec, & Menlove, 1966).

3. DSy superiority of females. Females will score higher than males on the DSy Test. This prediction is based on a large body of previous research in which females have been superior to males in DSy performance (Boor & Schill, 1967; Darley & Winitz, 1961; Gainer, 1962; Herman, 1968; Goodstein & Farber, 1957; Miele, 1958; Minuchin, 1963, 1964; Norman, 1953; Quereshi, 1968; Shaw, 1965; Wechsler, 1958).

4. DSy old age decrement. Young adults will score higher than elderly Ss on the DSy Test. This prediction also is based on a large body of previous research, which demonstrated a consistent and marked old age deficit in DSy performance (Berkowitz, 1953; Botwinick & Birren, 1951, 1963; Chesrow, Wosika, & Reinitz, 1949; Doppelt & Wallace, 1955; Eisdorfer & Cohen, 1961; Fox & Birren, 1950; Madonick & Solomon, 1947; Norman & Daley, 1959; Rabin, 1945; Wechsler, 1958).

5. Verbal mediation by age interaction. The age difference in DSy performance will be relatively less under the vocal mediation condition, resulting in an age by mediation interaction. This prediction is suggested by research which has shown that vocalized mediation benefits the old more than the young (Arenberg, 1968). Confirmation of this hypothesis would support the interpretation of the old age deficit in DSy performance as being in part due to an underlying vocal mediation deficit, which is ameliorated by vocal mediation instructions.

6. Verbal mediation by sex interaction. The sex difference in favor of females will be reduced under the competing vocalization condition because this condition will make it all but impossible to use verbal mediation. That is, if the S is vocalizing a repetitive series of over-learned verbalizations, he cannot at the same time be verbalizing, vocally or subvocally, the symbol labels. This will, therefore, tend to reduce the

female's advantage in DSy performance if this advantage derives from translating the DSy Test into a verbal task through the use of verbal mediation. Since females have greater verbal facility (Gari & Scheinfeld, 1968) than males, they should be superior to males under the two conditions which facilitate this translation, but should lose much of this advantage under the condition designed to prevent it (competing vocalization condition), thus resulting in a sex by mediation interaction. There may also be a tendency for males to be helped more by the vocal mediation condition than females because this condition will be of little additional help to Ss already mediating skillfully, thus creating a "ceiling effect" for the verbally facile females. Confirmation of this hypothesis would tend to support the interpretation of the DSy sex difference in terms of the hypothesized feminine superiority in verbal mediation.

7. Age by sex interaction. The sex difference in DSy performance will be greater within the young adult sample than within the old age sample, resulting in an age by sex interaction. This prediction is based on Wechsler's (1958) data which suggests a decrease in the sex difference among the elderly. This decrease could be explained as a function of the hypothesized decrement in spontaneous verbal mediation among the old, thus limiting the degree of translation of the DSy Test into a verbal task. This translation would otherwise tend to give

females an advantage because of their reported verbal fluency (Gari & Scheinfeld, 1968).

Secondary Hypotheses

In addition to the primary dependent variable, DSy raw score, exploratory data will also be collected so that simple tests of selected secondary hypotheses can be made. Similarly, some data will be collected for future analyses not directly related to the present study. The selected secondary hypotheses to be tested do not all seem equally plausible to the present author but are included because they represent logical alternative explanations of the DSy sex difference. As such, they need to be ruled out or confirmed as likely hypotheses for future experimentation. These secondary hypotheses each consist of two parts: (*a*) that some *S* characteristic is related to superior DSy performance, and (*b*) that this characteristic is found more frequently among females. Part *b* of each hypothesis only becomes relevant if part *a* is confirmed and if a DSy sex difference does occur in the experiment. These hypotheses are as follows:

1. *Verbal mediation and sex.* (*a*) *S*s high in the reported use of verbal mediation (regardless of experimental condition) will obtain higher DSy scores than *S*s low in reported use of verbal mediation. This is really a second test of the hypothesis that the use of verbal mediation enhances DSy performance.

The rationale is the same as for primary hypothesis number two. (b) Females will report a greater use of verbal mediation than males. This prediction is based on the superior verbal fluency of females (Gari & Scheinfeld, 1968).

2. Physical difference and sex. Gari and Scheinfeld (1968, p. 254) have hypothesized that the female's "delicate physique" is one factor "contributing to her superior manual dexterity." (a) Using reported body weight as a gross estimate of "delicate physique" Gari and Scheinfeld's (1968) hypothesis, extended to DSy performance, would suggest that weight and DSy raw score will be negatively related. That is, the lighter Ss should score higher than the heavier if the feminine superiority in DSy performance is due to their more "delicate physique." (b) Females, of course, will be lighter than males.

3. "Crabbed" handedness and sex. Previous research (Bonier & Hanley, 1961) suggests that "crabbed" handed Ss, those who bend their wrists so as to position the pencil between themselves and their writing hand, cover the DSy code key with their hand and arm, and consequently perform more poorly. (a) Therefore, it is expected that these Ss will score lower on the DSy Test than other Ss. (b) Following McCarthy (1961), it is hypothesized that more males than females will be left-handed and therefore will more often be "crabbed" handed.

4. Repetitive manual skills and sex. (a) Those Ss who use much of their leisure time in repetitive manual skills such

as knitting, sewing, crocheting, embroidering, and weaving will score higher on the DSy Test than those who do not. This is an exploratory hypothesis based on the rationale that the skills involved in such fine visual-manual repetitive activities will generalize to the relatively fine visual-manual, repetitive DSy task. "A priori" analysis did not suggest any comparable masculine leisure activity which involves repetitiveness and fine motor coordination as these activities do. (b) Females, of course, will report using more of their leisure time in these activities than males.

5. Motivation and sex. (a) Ss who report expending considerable effort ("trying hard") on the DSy Test will score higher than Ss reporting less effort expended. This is expected because of literature which emphasizes the important effect of motivation on the DSy Test (Glasser & Zimmerman, 1967; Oakland, 1969). (b) Females will report expending more effort than males will report. This prediction is based on the author's observation that in the elementary school setting girls tend to try hard even on intellectually unprovocative tasks, whereas boys more often tend to work hard only when the task is intrinsically interesting. Through their closer identification with elementary school teachers, girls perhaps learn to try to do their best even on repetitive, intellectually unstimulating tasks like DSy. This tendency may carry over into adulthood, thus

resulting in greater effort among the females in the study. The test of this hypothesis is admittedly tentative and exploratory because of the possible unreliability of the single self report item used.

CHAPTER III

Method

Subjects

The young adult sample consisted of 45 male and 45 female volunteers from Loyola University who were enrolled in the introductory psychology course. The old age sample consisted of 45 male and 45 female volunteers from St. Joseph's, St. Anthony's and Mother Theresa's Homes for the Aged, and from Mayslake Retirement Village. For each sex by mediation subgroup (15 Ss) the elderly sample included 6 Ss from Mayslake, 5 from St. Joseph's, 3 from St. Anthony's, and 1 from Mother Theresa's Home for the Aged. While all levels of functioning were represented in the homes for the aged, the Mayslake retirement sample included only those capable of completely independent living. It is felt that this combination of sampling sources resulted in a range of functional ability which was adequately representative of the aged. Although the aged and young adult samples appear roughly comparable in terms of socioeconomic and cultural factors, the average educational level of the young adults was inevitably higher than that of the elderly Ss. However, level of education was controlled statistically by using an analysis of covariance with level of education as the covariate.

The selection of _S_s for the old age sample presented some problems inasmuch as such _S_s are sometimes grossly handicapped by physical deficits such as auditory and visual impairment, not to mention varying degrees of senility. Yet, if only the best functioning elderly _S_s are selected for study, this makes the sample grossly unrepresentative of the elderly population. While no "perfect" solution to this problem is available, it was felt that the best plan was to follow the same procedure which was employed in screening elderly _S_s for the WAIS standardization sample for older persons (Doppelt & Wallace, 1955). This is an especially appropriate model, since the performance of elderly _S_s on the WAIS is compared to this standardization sample every time the WAIS old age norms are used. The few conditions under which a person in the standardization sample was not accepted as a _S_ were as follows (Doppelt & Wallace, 1955, p. 314):

> If the person was deaf, did not speak and understand English, or was so ill or handicapped that it might be a hardship for him to take the test, no attempt would be made to administer it.

In the case of the DSy Test, of course, blindness is added to this list of disqualifying characteristics. The implied final requirement for inclusion in the Doppelt and Wallace (1955) old age sample apparently was the actual ability and willingness of _S_s to complete the testing. That is, _S_s obviously unable to participate were eliminated from the sample immediately, and then additional Ss were eliminated whenever it was found that they too were unable to participate. The same selection criteria were applied to the present study.

Since the old age population sampled appeared to be extremely homogeneous in its racial characteristics (100% Caucasian), a similar homogeneity was sought in the young adult sample. This experimental precaution was deemed wise for two reasons. Firstly, there was a possibility, however small, that sociocultural differences associated with the racial composition of the samples might be confounded with the age variable. Secondly, preliminary research suggests that E-S dyads of the same race sometimes yield different results than E-S dyads of different races (Katz, Roberts, and Robertson, 1965). By keeping the racial composition of the samples constant between all subgroups of the design, such factors were controlled.

Instruments

The DSy Test used in this study was the DSy subtest of the WAIS. The standard WAIS record form was used, and 10 manifold carbon copy sets were hidden under the form in a manner similar to that reported by Wachtel and Blatt (1965) to measure DSy pencil pressure. The record form, with manifold carbon sets hidden and sealed within, was presented to each S in a clip-board. Even without the additional advantage of a clip-board to lock the materials in place and minimize flexibility and density cues, Wachtel and Blatt (1965, p. 305) were able to report that "none of the *Ss* was aware of the carbons beneath the test sheet." The pencil pressure data was collected as extra data, not related to the purposes of the present study, to be used for future analysis only. Well sharpened number two pencils were provided for each *S*.

A "Mediation Use Scale" was employed in order to measure the extent to which verbal mediation is reportedly employed by each *S*. The mediation score is simply the number of symbols reportedly labeled. A copy of this scale is provided in Appendix VI. Finally, a DSy Questionnaire was employed in order to test the secondary hypotheses and to provide an additional wealth of data for exploratory research which might follow and build upon the present study. A copy of the questionnaire is provided in Appendix VII.

The standardized scoring procedure for the WAIS DSy Test was followed with one minor conditional refinement. A modification of the standardized scoring procedure was tentatively planned in order to avoid a ceiling effect which would occur if many *Ss* obtained the maximum DSy raw score possible by correctly completing 90 items within the 90 second time limit. Thus, a *S* who correctly completed all of the items within 70 seconds would obtain the same score as a *S* who correctly completed all of the items in 90 seconds. The former *S*'s score is limited (ceiling effect) to 90 although he clearly is much speedier than the latter S. Although this ceiling effect could be avoided by increasing the number of items or decreasing the length of time allowed for performance, it was considered more desirable to keep the test administration itself just as it is in the standardized WAIS procedure.

One way to keep the test format exactly the same as in the standardized administration, and yet increase the upper limit of DSy scores, would be to assign bonus points to Ss completing all of the items before the end of the 90 second time limit. Since a S completing all of the items before 90 seconds had elapsed would have completed slightly more than one item per second, a conservative policy would be to credit such a S with one extra point for every second remaining in the 90 second period. This procedure was to be followed if 9 Ss (5%) or more of the total 180 Ss completed the DSy Test before the expiration of the 90 second time limit. Otherwise, the standardized scoring procedure was to be used without modification.

Procedure

The design of this experiment involved three independent variables: age (college students and elderly persons), sex, and mediation condition (vocal mediation, spontaneous mediation, and competing vocalization). Level of education (years of formal education), known to correlate positively with DSy score

(Wechsler, 1958) and negatively with advanced age (Anastasi, 1968), was treated as a covariate of age. Ss were randomly assigned to the three mediation conditions with the restriction that there was an equal number of males and females of each of the two age groups in each of the three conditions. This resulted in 15 Ss in each of the 12 subgroups.

The three mediation conditions were expected to differ in the level of verbal mediation which they tended to facilitate. In the vocal mediation condition, the S was asked to think of verbal labels for the symbols and to say them aloud as he drew them. In the competing vocalization condition, the S was instructed to say the months of the year over and over again while he drew the symbols, thus making spontaneous verbal mediation difficult or impossible. In the spontaneous mediation condition, the instructions paralleled the two other conditions without either a vocal mediation or a competing vocalization required. This condition corresponded to the standardized WAIS DSy instructions. In each condition, the actual DSy administration was preceded by a training task designed to familiarize each S with the procedural demands of his particular experimental condition. This task involved copying the symbols while saying the labels for them aloud (vocal mediation condition), while saying the months of the year (competing vocalization condition), or without any additional instructions other than to copy the symbols (spontaneous mediation condition). This training phase of the experiment was followed by instructions which paralled the WAIS standardized instructions except for brief reminders to also continue saying the labels in the vocal mediation condition or to continue saying the months of the year for Ss in the competing vocalization condition. The complete instructions for the three conditions are listed in Appendices III, IV, and V.

Following the DSy administration, the S was given the Mediation Use Scale (Appendix VI), and then the DSy Questionnaire (Appendix VII). Ss were asked not to discuss the experiment with others who had not yet participated in it. They were cautioned that their failure to honor this request might invalidate the performance of other Ss.

Statistical Analyses

The statistical analyses of the seven primary hypotheses listed in Chapter II involved an analysis of covariance, with Duncan's Multiple Range Test used to clarify any significant findings from the covariance analysis which required further specification. Specifically, the statistical procedures used to test the primary hypotheses were as follows:

1. Effectiveness of the experimental instructions. The effectiveness of the experimental instructions was measured by the number of marks reportedly labeled by Ss under each condition.

A three-way analysis of covariance involving age, sex, and mediation condition was used to test this hypothesis. The number of symbols reportedly labeled by each S served as the dependent variable, with education as the covariate. The effectiveness of the experimental instructions were to be accepted if the main effect of the mediation conditions were significant, with the vocal mediation condition eliciting more verbal labels than the competing vocalization condition or the spontaneous mediation condition.

2. Facilitating effect of verbal mediation. The hypothesis that the use of verbal mediation enhances DSy performance was to be accepted if the main effect of verbal mediation conditions were significant in a three-way analysis of covariance of DSy raw scores, involving age, sex, and mediation conditions (with educational level as a covariate), and if the mean DSy raw score obtained by Ss in the vocal and spontaneous mediation groups were higher than that obtained by the Ss in the competing vocalization group.

3. DSy superiority of females. The hypothesis that females score higher than males on the DSy Test was to be accepted if the main effect of sex were significant in a three-way analysis of covariance of DSy raw scores, involving age, sex, and mediation conditions (with educational level as a covariate), and if the mean DSy raw score obtained by females were higher than that obtained by males.

4. <u>DSy old age decrement</u>. The hypothesis that young adults score higher on the DSy Test was to be accepted if the main effect of age were significant in a three-way analysis of covariance of DSy raw scores, involving age, sex, and mediation conditions (with educational level as a covariate), and if the mean DSy raw score obtained by the young adult sample were greater than the mean DSy raw score obtained by the old age sample.

5. <u>Verbal mediation by age interaction</u>. The hypothesis that the DSy age deficit would be reduced under the vocal mediation condition was to be accepted if the age by mediation interaction were significant in a three-way analysis of covariance of DSy raw scores, involving age, sex, and mediation conditions (with educational level as a covariate), and if the age difference in DSy raw scores were lowest under the vocal mediation condition.

6. <u>Verbal mediation by sex interaction</u>. The hypothesis that the DSy superiority of females would be reduced by the competing vocalization condition was to be accetped if the sex by mediation interaction were significant in a three-way analysis of covariance of DSy raw scores, involving age, sex, and mediation conditions (with level of education as a covariate), and if the sex difference in DSy raw scores were lowest under the competing vocalization condition.

7. <u>Age by sex interaction</u>. The hypothesis that the DSy sex difference is of lesser magnitude among the old than among the young adults was to be accepted if the age by sex interaction were significant in a three-way analysis of covariance of DSy raw scores involving age, sex, and mediation conditions (with level of education as a covariate), and if the sex difference were of a lesser magnitude among the old than among the young.

The following section on the statistical analyses performed on the exploratory data (secondary hypotheses) requires a brief discussion of the considerations underlying the choice of the statistical tests. These considerations include the purely exploratory nature of the hypotheses and the simplified, possibly unreliable nature of the dependent measures used. Firstly, it should be noted that no attempt was made to "accept" or "reject" these hypotheses in the usual experimental sense. Rather, the purpose of gathering some data on them was to determine which, if any, seem to warrant experimental investigation. Secondly, the self report nature of the data and the simplicity and relative unreliability of the questionnaire items involved would make highly sophisticated and powerful statistical analysis an exercise in misplaced accuracy. The study would be complete without the secondary hypotheses, but it seemed to cost very little in time and effort to include them, as long as their exploratory nature were appreciated.

Separate statistical analyses were performed for each of the two age groups since significant but subtle findings might otherwise have been obscured by the gross differences associated with the age variable. It also seemed likely that many elderly Ss would not understand the rather introspective and intellective questionnaire items, thus decreasing their reliability for this group. The specific statistical procedures used with each hypothesis were as follows:

1. Verbal mediation and sex. (a) The hypothesis that Ss high in the reported use of verbal mediation (Mediation Use Scale) would obtain higher DSy scores than Ss low in the reported use of verbal mediation was to be accepted if the mean DSy score of the Ss ranking in the highest third of reported mediation (number of symbols reportedly labeled) were significantly higher than that of the Ss ranking in the lowest third. The significance of the difference between these means was analyzed by means of a *t* test. (*b*) The hypothesis that females would report a greater use of verbal mediation than males was to be tested if part *a* of the hypothesis were confirmed. It would be accepted if females reported more symbols labeled than males, the significance of this difference between means being assessed by means of a *t* test.

2. Physical difference and sex. (*a*) The hypothesis that Ss who weigh relatively little (Questionnaire data) would score

higher on the DSy Test than Ss who weigh relatively more was to be accepted if the mean DSy raw score of those Ss ranking in the lightest third of the Ss were significantly greater than the mean DSy raw score of those ranking in the heaviest third of the Ss. The significance of this difference between means was determined by a *t* test. (*b*) The hypothesis that females would be lighter than males was to be tested if part *a* were confirmed. It would be accepted if the mean weight of females were significantly less than that of males. The significance of the difference between these means was to be determined by a *t* test.

3. "Crabbed" handedness and sex. (*a*) The hypothesis that "crabbed" handed Ss would score lower on the DSy Test than other Ss was to be accepted if the mean DSy raw score of "crabbed" handed Ss (as observed by the E) were significantly lower than that of other Ss. The significance of this difference was determined by a *t* test. (*b*) The hypothesis that more males than females would use the "crabbed" handwriting style was to be tested if part *a* were confirmed. It would be accepted if significantly more males than females were observed to use this handwriting style. The significance of the difference in the frequency of each sex using the "crabbed" handwriting style was to be determined by a Chi-Square Test.

4. Repetitive manual skills and sex. (a) The hypothesis that Ss who use much of their leisure time in repetitive manual skills such as knitting, sewing, crocheting, embroidering, weaving, and similar activities would score higher on the DSy Test than those who use relatively little of their leisure time in such activities was to be accepted if the mean DSy raw score of those Ss ranking in the highest third of time spent in these activities (Questionnaire item #13) were significantly greater than that of those ranking in the lowest third. The significance of this difference was determined by a t test. (b) The hypothesis that females will report a greater use of these skills would be tested if part a is confirmed. It would be accepted if females were to report a significantly greater number of leisure hours spent in these activities than males report, the significance of the difference being determined by means of a t test.

5. Motivation and sex. (a) The hypothesis that those who report expending considerable effort on the DSy Test would obtain higher scores than those who report expending relatively little effort was to be accepted if the mean DSy raw score of those Ss ranking in the highest third of reported effort (Questionnaire item #5) were significantly higher than that of those ranking in the lowest third. The significance of this difference was determined by a t test. (b) The hypothesis that

females would try harder on the DSy Test than males would be accepted if the mean effort rating of females were significantly higher than that of males. The significance of the difference between the means was to be determined by a *t* test.

CHAPTER IV

Results

The results of this dissertation experiment are reported in four sections: preliminary data, primary hypotheses, secondary hypotheses, and supplementary findings.

Results I: Preliminary Data

The means and standard deviations of age for the old age sample and the young adult sample are presented in Tables 3 and 4, respectively. The level (years) of education of each sample is described similarly in Tables 5 and 6. The average age of the old age <u>S</u>s was 80.29, compared to 22.67 for the young adult <u>S</u>s. Inspection of Tables 3 and 4 suggests that the random assignment of <u>S</u>s to treatment conditions resulted in an apparently homogeneous distribution of age across all subgroups within each age sample. This observation was confirmed statistically, through a three-way analysis of variance with mediation condition, age, and sex as independent variables (Table 7). The only significant $\underline{F}$ ratio is that for age ($\underline{p} < .001$), reflecting the intended age difference between the young adult and old age samples which constitutes one of the independent variables. A similar analysis of variance was also performed in order to assess whether random assignment of

TABLE 3

Means and Standard Deviations of Age
for the Old Age Sample

Condition	Male	Female	Total
Spontaneous Mediation			
Mean	79.80	80.47	80.13
S.D.	5.55	5.86	5.79
Vocal Mediation			
Mean	80.93	80.33	80.63
S.D.	6.22	5.44	5.85
Competing Vocalization			
Mean	80.47	79.73	80.10
S.D.	6.86	5.00	6.01
Total			
Mean	80.40	80.18	80.29
S.D.	6.25	5.40	5.84

TABLE 4

Means and Standard Deviations of Age for the Young Adult Sample

Condition	Male	Female	Total
Spontaneous Mediation			
Mean	22.20	22.73	22.47
S.D.	3.62	3.50	3.56
Vocal Mediation			
Mean	22.67	23.13	22.90
S.D.	3.61	4.60	4.14
Competing Vocalization			
Mean	23.73	22.53	22.63
S.D.	4.25	3.25	3.75
Total			
Mean	22.53	22.80	22.67
S.D.	3.86	3.80	3.81

TABLE 5

Means and Standard Deviations of Years of Education for the Old Age Sample

Condition	Male	Female	Total
Spontaneous Mediation			
Mean	9.47	8.80	9.13
S.D.	3.68	2.74	3.27
Vocal Mediation			
Mean	7.93	8.60	8.27
S.D.	4.08	3.44	3.78
Competing Vocalization			
Mean	10.20	9.60	9.90
S.D.	2.46	3.46	3.01
Total			
Mean	9.20	9.00	9.10
S.D.	3.60	3.26	3.44

TABLE 6

Means and Standard Deviations of Years of Education for the Young Adult Sample

Condition	Male	Female	Total
Spontaneous Mediation			
Mean	14.00	13.67	13.83
S.D.	2.19	1.37	1.83
Vocal Mediation			
Mean	14.00	14.20	14.10
S.D.	1.51	2.20	1.89
Competing Vocalization			
Mean	14.33	14.20	14.27
S.D.	2.51	1.51	2.04
Total			
Mean	14.11	14.02	14.07
S.D.	2.11	1.76	1.94

TABLE 7

Analysis of Variance Summary

for Age

Source	SS	Df	MS	F
Mediation (M)	7.65	2	3.83	0.15
Age (A)	149413.92	1	149413.92	5722.48*
Sex (S)	.03	1	.03	0.00
M x A	1.08	2	.54	0.02
M x S	8.70	2	4.35	0.17
A x S	3.19	1	3.19	0.12
M x A x S	2.21	2	1.11	0.04
Error	4386.14	168	26.11	

* $p < .001$

Ss to groups resulted in any possibly confounding differences in level (years) of education (Table 8). Once again, the only significant *F* ratio is that for age, with the young adult sample having significantly more years of formal education than the old age sample ($p < .001$). This difference is a potential confound in assessing the effect of age upon DSy performance, and it was because this difference was anticipated that level of education data was chosen as the covariate in the analysis of DSy performance.

In the experimental procedure for the vocal mediation condition (Appendix III), provision was made for *Ss* who initially could not think of their own verbal labels for the symbols. It had been expected that this might often be the case with the elderly *Ss*. With *Ss* who initially could not provide their own label for a symbol, the *E* was to suggest a common, popular label for it. This procedure was necessary with 36.67% of the 30 elderly *Ss* in the vocal mediation condition and only 3.33% of the corresponding young adult *Ss*. No *S* required this assistance with more than two symbols. The vast majority (83.33%) of those who needed this help needed it for only one symbol. Special instructions were also developed for any *Ss* who would use inappropriately long labels (Appendix III), but this difficulty did not occur. The frequency distributions of the labels used by the *Ss* for each symbol are listed in Tables 9 and 10.

TABLE 8

Analysis of Variance Summary for

Years of Education

Source	SS	Df	MS	F
Mediation (M)	25.20	2	12.60	1.57
Age (A)	1110.05	1	1110.05	138.41*
Sex (S)	0.94	1	0.94	0.12
M x A	17.72	2	8.86	1.10
M x S	7.64	2	3.82	0.48
A x S	0.14	1	0.14	0.02
M x A x S	1.93	2	0.97	0.12
Error	1348.13	168	8.02	

* $p < .001$

TABLE 9

Frequency Distribution of the Labels Used for

Each Symbol by the Old Age Sample

Symbols		Labels	Male	Female	Total
(1)	—	Dash	10	11	21
		Minus, Subtract, etc.	3	5	8
		Line	6	6	12
		Other	3	4	7
		Total	22	26	48
(2)	⊥	Upside-down T	11	21	32
		T (Letter)	11	6	17
		Other	1	0	1
		Total	23	27	40
(3)	⊐	Backwards (or Inverted) C	7	7	14
		C (Letter)	8	7	15
		E (Letter)	0	1	1
		Other	3	3	6
		Total	18	18	36
(4)	L	L (Letter)	23	30	53
		Other	0	1	1
		Total	23	31	54
(5)	U	U (Letter)	24	29	53
		Other	0	0	0
		Total	24	29	53
(6)	O	O (Letter)	23	29	52
		Zero	2	0	2
		Other	0	1	1
		Total	25	30	55

Continued

TABLE 9—Continued

Symbols		Labels	Male	Female	Total
(7)	∧	Upside-down V	9	20	29
		V (Letter)	7	4	11
		A (Letter)	3	0	3
		Other	2	2	4
		Total	21	26	47
(8)	×	X (Letter)	23	28	51
		Other	1	0	1
		Total	24	28	52
(9)	=	Equal, Equal Sign, etc.	9	11	20
		Two Lines	7	10	17
		Other	3	3	6
		Total	19	24	43

TABLE 10

Frequency Distribution of the Labels Used for

Each Symbol by the Young Adult Sample

Symbols		Labels	Male	Female	Total
(1)	—	Dash	12	14	26
		Minus, Subtract, etc.	10	4	14
		Line	1	5	6
		Other	2	4	6
		Total	25	27	52
(2)	⊥	Upside-down T	10	16	26
		T (Letter)	5	2	7
		Perpendicular	4	3	7
		Other	1	3	4
		Total	20	24	48
(3)	⊃	Backwards (or Inverted) C	9	12	21
		C (Letter)	3	1	4
		Bracket	2	2	4
		Other	3	5	8
		Total	17	20	37
(4)	L	L (Letter)	22	21	43
		Other	4	4	8
		Total	26	25	51
(5)	U	U (Letter)	23	25	48
		Other	3	1	4
		Total	26	26	52
(6)	O	O (Letter)	17	15	32
		Zero	8	7	15
		Circle	2	5	7
		Other	0	1	1
		Total	27	28	55

Continued

TABLE 10—Continued

Symbols		Labels	Male	Female	Total
(7)	$\wedge$	Upside-down V	9	19	28
		V (Letter)	5	3	8
		Other	8	3	11
		Total	22	25	47
(8)	$\times$	X (Letter)	20	28	48
		Multiply, Multiplication Sign, etc.	5	1	6
		Other	0	1	1
		Total	25	30	55
(9)	$=$	Equal, Equal Sign, etc.	26	27	53
		Other	0	2	2
		Total	26	29	55

Regarding the competing vocalization procedures (Appendix IV), it seemed possible that elderly Ss might have difficulty vocalizing the months of the year. However, all Ss in the study were able to vocalize the months without difficulty, and at a rate, during the practice period, of more than one month per second. It was observed that many of the Ss in this condition tended to vocalize one month for each symbol that they drew, although this tempo was not demanded by the instructions. No special problems were anticipated in the spontaneous mediation condition, and none occurred. It was observed that many Ss in this condition vocalized labels for some symbols spontaneously, and that this occurred among both the young and the old. No systematic recording of this had been planned, but after noticing that many of the young Ss did spontaneously vocalize labels, the author decided to record this behavior more systematically for the elderly Ss. Among the elderly, 36.67% of the Ss in the spontaneous mediation condition vocalized at least some labels spontaneously, compared with 0% of those in the competing vocalization condition.

One final concern which proved to be unimportant was the possibility of a ceiling effect which could occur if many Ss completed the full 90 DSy items within the 90 seconds time limit. A contingency scoring plan which would have compensated for this was to be used if 5% or more of the Ss accomplished this. As it turned out, only one S (a 20 year old female in the SM condition) completed all of the items, and she needed the full time limit to do so. Consequently, no adjustment for ceiling effects were needed. With all of these preliminary considerations completed, the data pertaining to the hypotheses being tested can now be presented.

Results II: Primary Hypotheses

1. Effectiveness of experimental instructions. The first of the seven primary hypotheses, as listed in Chapter II, was that the use of verbal mediation as measured by the number of symbols reportedly labeled (Mediation Use Scale, Appendix VI) would be significantly greater in both the vocal and spontaneous mediation conditions than in the competing vocalization condition. The means and standard deviations of the verbal mediation scores for the old age sample are presented in Table 11 and those for the young adult sample are presented in Table 12. Tables 13 and 14 summarize the three-way analysis of covariance and variance, respectively, of the verbal mediation scores. In the analysis of covariance, level of education was used as the covariate. As Tables 13 and 14 reveal, the mediation variable is significant ($p < .001$) in each analysis, and the two F ratios are almost identical.

Since there is no indication that the covariate affected verbal mediation scores (and since the computer program employed

TABLE 11

Means and Standard Deviations of Verbal Mediation Scores for the Old Age Sample

Condition	Male	Female	Total
Spontaneous Mediation			
Mean	2.47	5.33	3.90
S.D.	3.28	1.85	3.44
Vocal Mediation			
Mean	8.93	8.67	8.80
S.D.	0.36	0.83	0.66
Competing Vocalization			
Mean	2.07	2.20	2.13
S.D.	3.45	3.71	3.59
Total			
Mean	4.49	5.40	4.94
S.D.	4.18	3.87	4.06

TABLE 12

Means and Standard Deviations of Verbal Mediation Scores for the Young Adult Sample

Condition	Male	Female	Total
Spontaneous Mediation			
Mean	3.60	4.47	4.03
S.D.	3.48	3.55	3.54
Vocal Mediation			
Mean	9.00	9.00	9.00
S.D.	0.00	0.00	0.00
Competing Vocalization			
Mean	1.67	2.13	1.90
S.D.	2.49	3.06	2.80
Total			
Mean	4.76	5.20	4.98
S.D.	3.97	3.93	3.95

TABLE 13

Analysis of Covariance Summary
for Verbal Mediation Scores

Source	SS	Df	MS	F
Mediation (M)	1528.50	2	764.25	99.18**
Age (A)	6.75	1	6.74	0.88
Sex (S)	21.63	1	21.63	2.81*
M x A	0.93	2	0.46	0.06
M x S	35.84	2	17.92	2.33
A x S	2.58	1	2.58	0.33
M x A x S	13.64	2	6.82	0.89
Error	1286.89	167	7.71	

* $p < .10$

** $p < .001$

TABLE 14

Analysis of Variance Summary

for Verbal Mediation Scores

Source	SS	Df	MS	F
Mediation (M)	1510.41	2	755.21	97.22*
Age (A)	0.05	1	0.05	0.01
Sex (S)	20.67	1	20.67	2.66
M x A	1.63	2	0.82	0.11
M x S	33.21	2	16.61	2.14
A x S	2.45	1	2.45	0.32
M x A x S	13.23	2	6.61	0.85
Error	1305.05	168	7.77	

* $p < .001$

did not print out adjusted means), the raw score unadjusted means were used in further specifying the significant difference due to the mediation or instructional variable. The means for the vocal mediation, spontaneous mediation, and competing vocalization conditions, summed across age and sex are 8.90, 3.97, and 2.02, respectively. A Duncan multiple range test was used to determine which of these means differ significantly from each other. The results of the range test analysis were that each of the three conditions differed from each other at a high level of statistical significance ($p < .001$). Thus, the hypothesis that the vocal mediation and spontaneous mediation conditions would each elicit higher verbal mediation scores than the competing vocalization condition is accepted.

The basic statistics and analyses necessary for evaluating the remaining six primary hypotheses are presented in Tables 15 through 18. Tables 15 and 16 list the means and standard deviations of DSy scores for the old age and young adult samples, respectively. These descriptive statistics are presented for each age, sex, and mediation condition. Table 17 summarizes the analysis of covariance of DSy scores, involving age, sex, and mediation condition as the independent variables, DSy raw scores as the dependent variable, and level (years) of education as the covariate. Inasmuch as adjusted means were not available from the computer program used for the analysis of

TABLE 15

Means and Standard Deviations of DSy

Scores for the Old Age Sample

Condition	Male	Female	Total
Spontaneous Mediation			
Mean	20.40	18.47	19.43
S.D.	11.85	9.21	10.67
Vocal Mediation			
Mean	18.20	19.93	19.07
S.D.	14.61	9.57	12.37
Competing Vocalization			
Mean	19.47	23.00	21.23
S.D.	10.73	10.02	11.94
Total			
Mean	19.36	20.47	19.91
S.D.	12.54	10.81	11.72

TABLE 16

Means and Standard Deviations of DSy

Scores for the Young Adult Sample

Condition	Male	Female	Total
Spontaneous Mediation			
Mean	61.13	71.60	66.37
S.D.	9.72	9.46	10.92
Vocal Mediation			
Mean	59.73	58.80	59.27
S.D.	8.34	9.09	8.72
Competing Vocalization			
Mean	53.87	55.80	54.83
S.D.	13.42	8.60	11.32
Total			
Mean	58.24	62.07	60.16
S.D.	11.16	11.35	11.42

TABLE 17

Analysis of Covariance Summary

for DSy Scores

Source	SS	Df	MS	F
Mediation (M)	989.11	2	494.56	4.60**
Age (A)	28865.34	1	28865.34	268.23****
Sex (S)	316.82	1	316.82	2.94*
M x A	1287.09	2	643.54	5.98***
M x S	204.53	2	102.26	0.95
A x S	71.70	1	71.70	0.67
M x A x S	486.55	2	243.27	2.26
Error	17971.78	167	107.62	

* $p < .10$

** $p < .025$

*** $p < .005$

**** $p < .001$

TABLE 18

Analysis of Variance Summary

for DSy Scores

Source	SS	Df	MS	F
Mediation (M)	778.13	2	389.07	3.12*
Age (A)	72882.66	1	72882.63	583.70***
Sex (S)	273.80	1	273.80	2.19
M x A	1333.43	2	666.72	5.34**
M x S	113.73	2	56.87	0.46
A x S	82.78	1	82.78	0.66
M x A x S	528.13	2	264.06	2.11
Error	20976.91	168	124.86	

* $p < .05$

** $p < .01$

*** $p < .001$

covariance, and since it was suspected that a parallel analysis of variance would yield substantially the same results and involve fewer statistical assumptions, an analysis of variance using the same variables was performed. This analysis has been summarized in Table 18. Note that the same variables, at nearly the same levels of significance, are statistically significant in both the analysis of variance and the analysis of covariance. The primary effect of statistically controlling the covariate, aside from making two out of the three significant factors slightly more significant, was to reduce the enormous $\underline{F}$ value for age of 583.70 in the analysis of variance to the still enormous $\underline{F}$ value of 268.23 in the analysis of covariance. Level of education was distributed equitably across all variables except age, and the difference in DSy scores due to age was so enormous that statistical adjustment for the covariate had no important effect on the results. The significant factors and the nonsignificant factors are the same in each analysis. Since it makes no practical difference whether scores weighted for the effect of the covariate or scores not weighted for its effect are used, and since some authors (e.g. Winer, 1962) suggest that the use of an unweighted analysis is preferable when the covariate is not homogeneously distributed across all independent variables, the raw score, unweighted means were used to further specify all significant results. The results concerning each of the remaining six primary hypotheses now can be presented, with the above considerations being applied.

2. <u>Facilitating effect of verbal mediation</u>. The second primary hypothesis was that the three different mediation conditions would result in significant differences in DSy performance, with the vocal mediation and spontaneous mediation conditions resulting in better performance than the competing vocalization condition. The analysis of covariance summarized in Table 17 and the corresponding analysis of variance summarized in Table 18 each resulted in a significant main effect for mediation conditions ($p < .025$ and $p < .05$, respectively) as predicted. The DSy means for the spontaneous mediation, vocal mediation, and competing vocalization conditions, summed across age and sex, are 42.90, 39.17, 38.03, respectively. These means are in the predicted order, with the vocal mediation and spontaneous mediation conditions both higher in DSy scores than the competing vocalization condition. Furthermore, they are in the same order as the means for the verbal mediation scores already reported, thus suggesting a positive relationship between the degree of verbal mediation employed and DSy performance scores. This would suggest that the hypothesis concerning the facilitating effect of verbal mediation should be accepted.

However, inspection of Tables 15 and 16 reveals that while the DSy means for the young adult sample are clearly in the predicted direction, those for the old age sample do not conform to the same pattern. In particular, whereas the competing vocalization condition produced the lowest mean DSy score among the young adults, it produced the highest mean DSy score among the elderly. This situation is reflected in the significant interaction of mediation and age in the analysis of covariance ($p < .005$) and also in the analysis of variance ($p < .01$). This interaction is presented graphically in Figure 1. The line representing the DSy performance of the elderly, plotted for each of the three conditions, departs very little from the horizontal, suggesting that it made little difference to those in the old age sample whether they were prevented from using verbal mediation (competing vocalization condition), taught to use it (vocal mediation condition), or left on their own as to whether they would use verbal mediation (spontaneous mediation condition). However, for the young adult Ss, the predicted order of the conditions in terms of DSy performance was obtained, with the spontaneous mediation condition clearly eliciting the best performance, followed by the verbal mediation and competing vocalization conditions in that order. Consequently, the hypothesis of the facilitating effect of verbal mediation is accepted, but only with the qualification that the effect of variations in verbal mediation depends upon the age level of the S. That is, conditions which instruct or permit the S to

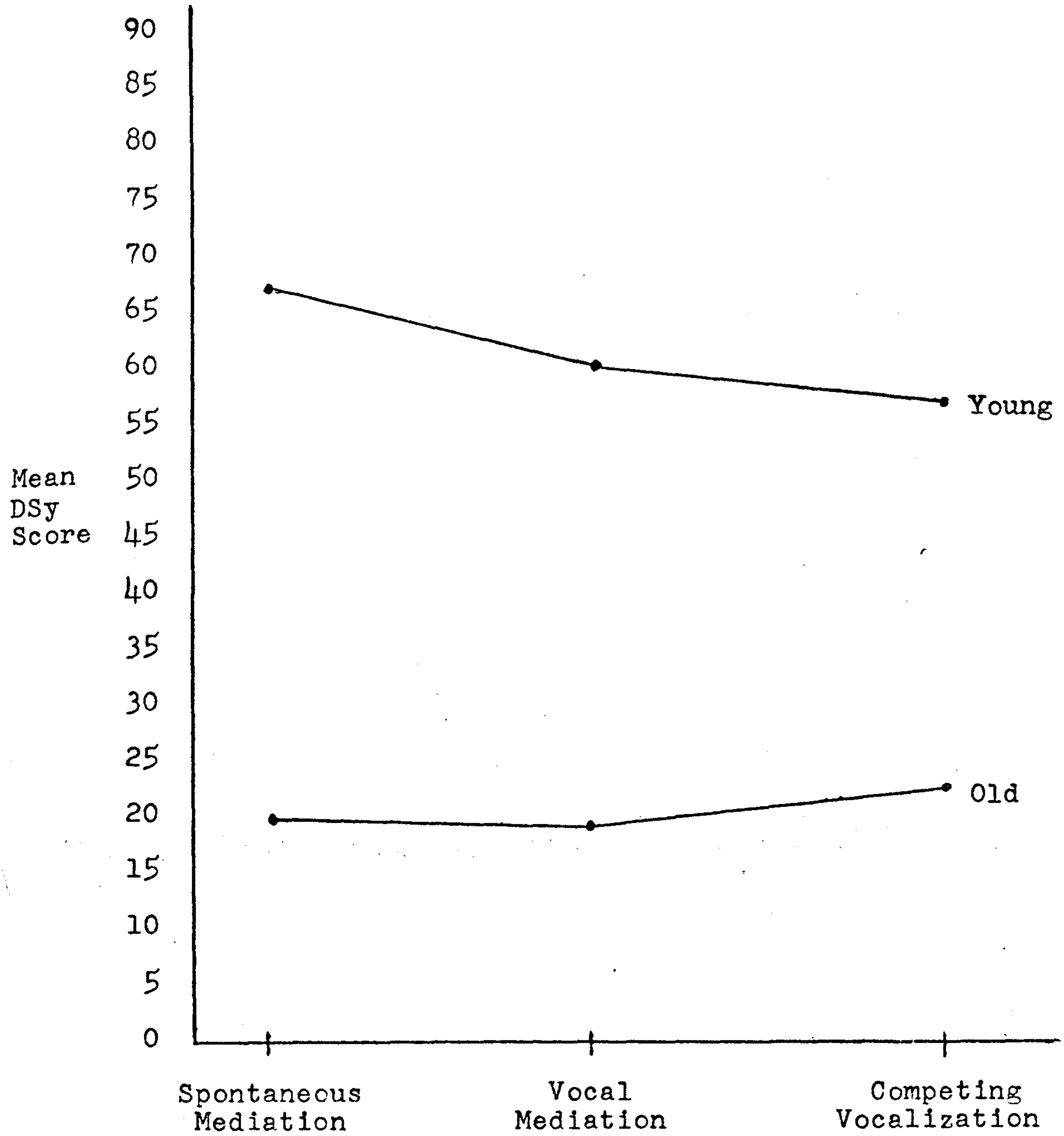

Fig. 1. Graph of the interaction of mediation conditions and age on DSy performance.

use verbal mediation improve the performance of young adult Ss, but have no apparent influence on the performance of elderly Ss.

3. DSy superiority of females. The third primary hypothesis was that females would score higher than males on the DSy Test. The means and standard deviations of DSy scores for each sex and mediation subgroup are presented in Table 15 for the elderly Ss and in Table 16 for the young adult Ss. The over-all means for each sex, summed across age and mediation conditions were 38.80 for males and 41.27 for females. Although this difference is in the predicted direction, reference to Table 17 reveals that the main effect of sex is only marginally significant in the analysis of covariance ($p < .10$). In the analysis of variance (Table 18), the main effect of sex reaches only a suggestive level of significance ($p < .20$). Thus, based only on the data of the present experiment, the hypothesis of the DSy superiority of females would not be accepted at a satisfactory level of confidence.

4. DSy old age decrement. The fourth primary hypothesis was that young adults would score higher than elderly Ss on the DSy Test. Examination of the means of Tables 15 and 16 reveals that in every subgroup, the young adults were vastly superior to the elderly Ss. The over-all means for each age group, summed across sex and mediation condition are 19.91 for the old age sample and 60.16 for the young adult sample. Needless to

say, the main effect of age in both analyses was highly significant ($p < .001$). The mediation condition and age interaction was also significant in both the analysis of covariance ($p < .005$) and in the analysis of variance ($p < .01$). The difference between the two age groups is so great, however, that no qualifications of the DSy old age decrement are necessary. Note that in Figure 1 the lines representing the two age groups are not parallel, but neither do they come anywhere near intersecting in this experiment. Furthermore, the line representing young adult performance is greatly elevated at all points over the line representing senescent performance. Thus, the hypothesis of a decrement in the DSy performance of elderly _Ss_ was overwhelmingly confirmed. The interaction between age and mediation condition simply suggests that the age difference is reduced slightly by the special instructions of either the vocal mediation condition or the competing vocalization condition.

5. _Verbal mediation by age interaction_. The fifth primary hypothesis was that the age difference in DSy performance would be relatively less under the vocal mediation condition. That is, it was predicted that the age decrement would be reduced by the special instructions designed to have _Ss_ vocalize labels for the symbols as they filled them in during their DSy performance. A significant interaction was obtained between

mediation condition and age in the analysis of covariance ($p < .005$) and in the analysis of variance ($p < .01$), but it was not exactly as predicted. Examination of the DSy means in Tables 15 and 16 and of the graph of DSy performance in Figure 1 reveal that the DSy age difference was intermediate in the vocal mediation condition, greatest in the spontaneous mediation condition, and smallest in the competing vocalization condition. There were no reliable differences due to mediation conditions in the old age sample, and if anything, it was the competing vocalization condition which improved the DSy performance of the elderly.

6. Verbal mediation by sex interaction. The sixth primary hypothesis was that the sex difference in favor of females would be reduced in the competing vocalization condition, and to a lesser extent also under the vocal mediation condition. As indicated in Tables 17 and 18, the interaction of mediation conditions and sex failed to reach significance in both the analysis of covariance and the analysis of variance. Therefore, the hypothesis of a differential effect of sex depending on mediation condition was not confirmed. Inspection of the means in Table 16, however, reveals that among the young, the sex difference in favor of females was considerable in the spontaneous mediation condition, but minimal (competing vocalization) or even in the opposite direction (vocal mediation) in

the other conditions. This pattern was not found in the old age sample (Table 15). The relevant three-way interaction was of only suggestive significance ($p < .20$) in the analyses of covariance (Table 17) and variance (Table 18).

7. Age by sex interaction. The seventh and final primary hypothesis was that the sex difference in DSy performance would be greater within the young adult sample than within the old age sample, resulting in a significant age by sex interaction effect. Refering once again to Tables 15 and 16 for an examination of the DSy means, and subtracting the total mean DSy score for young adult males from that of young adult females as listed in Table 16, a difference of 3.83 is obtained. The corresponding difference in the old age sample (Table 15) is 1.11. Thus, the sex difference was greater among the young adults than among the elderly *Ss*, but the interaction effect of age and sex was not significant in either the analysis of covariance (Table 17) or the analysis of variance (Table 18). Therefore, the hypothesis of a greater sex difference among the young than among the old was not confirmed at an acceptable level of statistical significance.

Results III: Secondary Hypotheses

As discussed in the Method Chapter, the plan for analyzing the secondary hypotheses was to (*a*) determine whether the relevant *S* characteristic is related to DSy performance at a significant level, and (b) then to determine whether the S characteristic in question is found more in males or in females. However, part b of the two part analysis was to be performed only if part a yielded a significant relationship, and if a significant sex difference was found to occur in the analysis of the main effect of sex. As has already been reported, the main effect of sex was not significant. However, since it did approach an acceptable level of significance, there is some rationale for examining the sex difference on a purely exploratory level. At any rate, the S characteristics under study are themselves of some potential significance, so the analyses were performed as planned. In order to control for the effects of sex and mediation condition, the upper and lower thirds of each subgroup within each age sample were selected for comparison. The results are presented in Tables 19 and 20.

1. Verbal mediation and sex. The first secondary hypothesis was that Ss high in reported use of verbal mediation, as measured by the Mediation Use Scale (Appendix VI), would obtain higher DSy scores than Ss low in the reported use of verbal mediation. This hypothesis was designed to be a second test of the effectiveness of verbal mediation, but unlike the primary hypothesis, it is based on the degree of verbal mediation actually employed, or at least reported, by each S, regardless of which experimental mediation instructions he received. In

TABLE 19

DSy Means, *n*'s, and *t* values for Each of the Five Secondary Hypotheses for the Old Age Sample

Secondary Hypothesis	*n*	DSy Mean	*t*
1. Verbal Mediation			
High Mediation	20	20.20	0.39
Low Mediation	20	18.60	
2. Physical Difference			
Heavy	30	21.27	1.12
Light	30	17.93	
3. Handedness[a]			
4. Repetitive Manual Activities (RMA)			
High RMA	15	20.93	0.25
Low RMA	15	21.93	
5. Motivation			
High Motivation	30	18.30	1.01
Low Motivation	30	21.30	

[a] Because there was only one left-handed elderly *S*, this hypothesis could not be tested for the old age sample.

TABLE 20

DSy Means, *n*'s, and *t* values for Each of the Five Secondary Hypotheses for the Young Adult Sample

Secondary Hypothesis	*n*	DSy Mean	*t*
1. Verbal Mediation			
High Mediation	20	61.70	0.48
Low Mediation	20	59.60	
2. Physical Difference			
Heavy	30	59.13	0.75
Light	30	61.13	
3. Handedness			
Left-Handed	10	55.40	0.94
Right-Handed	10	60.30	
Left-Crabbed	7	54.71	0.77
Right-Handed	7	59.57	
4. Repetitive Manual Activities (RMA)			
High RMA	15	58.47	0.80
Low RMA	15	61.73	
5. Motivation			
High Motivation	30	64.53	2.48*
Low Motivation	30	56.40	

* $p < .02$, 2-tail test, *df* = 58

order to control for the effects of age, sex, and mediation instructions, and thus measure the effects of verbal mediation independent of these variables, the five *Ss* highest in verbal mediation within each subgroup were combined to form the high mediation sample, and the five lowest from each subgroup were combined to form the low mediation sample. However, *Ss* in the vocal mediation condition were excluded because they all reported nearly 100% verbal mediation. For each age category, this resulted in 20 *Ss* high in mediation and 20 *Ss* low in mediation. The DSy means of these groups and the resulting *t* values are presented in Table 19 for the elderly sample and Table 20 for the young adult sample. Both the *t* test for the elderly sample ($t = .39$) and that for the young adult sample ($t = .48$) were found to be statistically insignificant. Thus, the secondary hypothesis of the facilitating effect of reported verbal mediation was not confirmed for either age group.

2. *Physical difference and sex*. The second hypothesis in the secondary series was that, using reported body weight as a gross measure of "delicacy of physique" (Gari & Schienfeld, 1968), the lighter *Ss* would score higher than the heavier *Ss* in their DSy performance. Once again the effects of sex and mediation condition were controlled by selecting the five highest and the five lowest in weight from each sex by mediation subgroup. Again, the two age groups were analyzed

separately. The resulting t test between the DSy means of the heavy and the light was insignificant for the elderly ($t = 1.12$) and for the young ($t = .75$), as indicated in Tables 19 and 20. Thus, the secondary hypothesis of the facilitating effect of delicacy of physique as measured by reported weight was not confirmed for either age group.

3. "Crabbed" handedness and sex. The third secondary hypothesis was that "crabbed" handed Ss would obtain lower DSy scores than other Ss. Table 21 reveals that there were very few "crabbed" handed Ss in the young adult sample, and none in the old age sample, except for one right-handed S. Since the hypothesis advanced by Bonier and Hanley (1961) apparently assumed that only left-handed Ss would be "crabbed" handed, only these left-handed "crabbed" Ss were used in the present analysis. The left-handed "crabbed" Ss in the young adult sample were compared to an equal number of randomly chosen right-handed Ss, and did not differ significantly from them in DSy performance ($t = .77$), as indicated in Table 20. Nor did the left-handed Ss of the young adult sample, regardless of handwriting style, differ significantly from an equal number of randomly chosen right-handed young adult Ss ($t = .94$). Thus, the effects of "crabbed" handedness and left-handedness in general are unrelated to DSy performance at any acceptable level of significance. However, "crabbed" and regular left-handed Ss

TABLE 21

Distribution of "Crabbed" Handedness among Left-Handed Ss for Each Age, Sex, and Experimental Condition

Sex	Young	Old	Total
		Spontaneous Mediation	
Male	1	0	1
Female	0	0	0
Total	1	0	1
		Verbal Mediation	
Male	0[a]	0	0
Female	1	0	1
Total	1	0	1
		Competing Vocalization	
Male	1	0[a]	1
Female	4[a]	0	4
Total	5	0	5
TOTAL	7	0	7

[a] 1 Right "Crabbed" Handed S.

did tend to score lower in DSy performance, and a study involving more left-handed and left "crabbed" handed Ss might well obtain significant results. The present hypothesis of a "crabbed" handed deficit cannot be accepted, however, and it should be noted (Tables 21 and 22) that there were actually more female left-handed "crabbed" Ss (n = 5) than male left-handed "crabbed" Ss (n = 2), and there were even more left-handed female Ss over-all (n = 6) than male left-handed Ss (n = 5).

4. Repetitive manual skills and sex. The fourth secondary hypothesis was that those who use much of their leisure time in repetitive manual activities such as knitting, sewing, crocheting, embroidering, and weaving would score higher on the DSy Test than those who do not. The results of the relevant DSy Questionnaire item (#13) were that no males used their leisure time in this manner. Accordingly, only the female Ss were used in this analysis. The five highest and the five lowest female Ss from each subgroup, in terms of these sewing types of activities, were selected for comparison. This resulted in 15 elderly Ss high in hours reportedly spent in these repetitive manual activities and 15 elderly Ss low in hours reportedly spent in these activities. The mean DSy scores of these resulting groups (Table 19) were compared and subjected to a t test, which yielded insignificant results

TABLE 22

Distribution of Left-Handedness for Each

Age, Sex, and Experimental Condition

Sex	Young	Old	Total
		Spontaneous Mediation	
Male	2	0	2
Female	0	0	0
Total	2	0	2
		Verbal Mediation	
Male	0	0	0
Female	1	1	2
Total	1	1	2
		Competing Vocalization	
Male	3	0	3
Female	4	0	4
Total	7	0	7
TOTAL	10	1	11

(t = .25). A parallel analysis was performed for the young adult sample, and also yielded insignificant results (t = .80). Therefore, the hypothesis that repetitive manual skills such as knitting, sewing, crocheting, embroidering and weaving are significantly related to DSy performance cannot to accepted.

5. Motivation and sex. The fifth and final secondary hypothesis was that the Ss who report expending considerable effort on the DSy Test (Questionnaire item #5) would obtain higher DSy scores than the Ss who report relatively less effort so expended. The mean DSy score of the five most motivated Ss in each subgroup among the old age sample was 18.30 compared to 21.30 for the least motivated elderly Ss. The t value (t = 1.01) between these two means was not significant. Furthermore, the difference was not even in the predicted direction. For the young adult sample, however, the mean for the most motivated Ss was 64.53 compared to 56.40 for the least motivated Ss. The resulting t value was significant (t = 2.48, $p < .02$), thus suggesting that for the young adult Ss, level of motivation was a significant factor in DSy performance. The fifth secondary hypothesis is accepted for the young adult sample, but rejected for the old age sample.

If this motivational difference is to be used to explain the tendency for young adult females to obtain higher DSy scores than young adult males, then young adult females should report a higher level of motivation than the corresponding males. The mean motivation score for the adult males was 4.04 and that for the adult females was 3.67. Thus, the motivation score means are not even in the predicted direction in order to account for the tendency of females to score higher than males. The difference in favor of males being more highly motivated in DSy performance approaches significance ($t = 1.68$, $p < .10$). Thus, while level of motivation seems to be positively related to DSy performance ($p < .02$), for the young adults, it is the young males rather than the young females who tend to be more highly motivated on the DSy Test. This is contrary to part b of the fifth secondary hypothesis which proposed an elevated feminine level of motivation as responsible for the DSy sex difference.

Results IV: Supplementary Findings

1. Association recall. One of the items of the DSy Questionnaire (Appendix VII) was item number 15 which presented the nine digits in order and called for the S to fill in the associated symbols as they appeared on the DSy Test. This task required the S to recall associations which he was never explicitly asked to learn. Further complicating the S's task was the intervening mental activity involved in completing 14 previous questionnaire items since he actually worked with the digits and their corresponding symbols.

Tables 23 and 24 present the means and standard deviations of association recall scores for the various subgroups and

TABLE 23

Means and Standard Deviations of Association Recall Scores for the Old Age Sample

Condition	Male	Female	Total
Spontaneous Mediation			
Mean	2.67	2.67	2.67
S.D.	1.95	2.44	2.21
Vocal Mediation			
Mean	3.47	3.40	3.43
S.D.	2.50	3.05	2.79
Competing Vocalization			
Mean	3.13	2.47	2.80
S.D.	1.79	1.96	1.91
Total			
Mean	3.09	2.84	2.97
S.D.	2.13	2.56	2.35

TABLE 24

Means and Standard Deviations of

Association Recall Scores for

the Young Adult Sample

Condition	Male	Female	Total
Spontaneous Mediation			
Mean	6.73	6.87	6.80
S.D.	2.15	2.05	2.10
Vocal Mediation			
Mean	6.67	7.47	7.07
S.D.	2.17	1.95	2.11
Competing Vocalization			
Mean	4.73	5.73	5.23
S.D.	2.47	1.99	2.29
Total			
Mean	6.04	6.69	6.37
S.D.	2.45	2.13	2.31

conditions. A S's association recall score is simply the number of symbols which he filled in correctly during the recall task. The Ss were given an unlimited amount of time to complete this item, which was chosen for analysis not because it is intrinsically important to the main purposes of the present study, but because the important earlier study by Koestline and Dent (1969) found that verbal mediation training did affect recall for the symbols while not affecting DSy performance. Furthermore, many Ss reported to the present investigator that they regarded this recall task as the main purpose of the study. Also, the processes affecting the learning and memory of elderly Ss constitutes an important area of study in its own right.

Consequently, an analysis of covariance of association recall scores was performed, with age, sex, and mediation condition as independent variables and level (years) of education as the covariate. This analysis of covariance is summarized in Table 25, and the corresponding analysis of variance is presented in Table 26. As in the preceding analyses, essentially the same findings were obtained whether or not DSy scores were adjusted for the covariate, so that the unadjusted data are preferable. In both the analysis of variance and the analysis of covariance, the main effects of age are highly significant. The statistical significance of the age variable ($p < .001$) clearly reflects the superiority of the young adults over the

TABLE 25

Analysis of Covariance Summary

for Association Recall Scores

Source	SS	Df	MS	F
Mediation (M)	60.39	2	30.20	6.08*
Age (A)	144.56	1	144.56	29.09**
Sex (S)	2.39	1	2.39	0.48
M x A	19.97	2	9.98	2.01
M x S	0.08	2	0.04	0.01
A x S	8.43	1	8.43	1.70
M x A x S	4.31	2	2.15	0.43
Error	829.92	167	4.97	

* $\underline{p} < .005$

** $\underline{p} < .001$

TABLE 26

Analysis of Variance Summary
for Association Recall Scores

Source	SS	Df	MS	F
Mediation (M)	46.03	2	23.02	4.31*
Age (A)	520.20	1	520.20	97.42**
Sex (S)	1.80	1	1.80	0.34
M x A	22.90	2	11.45	2.14
M x S	0.70	2	0.35	0.07
A x S	8.89	1	8.89	1.66
M x A x S	4.41	2	2.20	0.41
Error	897.05	168	5.34	

* $p < .025$

** $p < .001$

elderly Ss in association recall ability. The significance of the mediation conditions in the analysis of covariance ($p < .005$) and in the analysis of variance ($p < .025$) required further clarification, however. The over-all association recall means for the three mediation conditions, summed across age and sex were 4.02 for the competing vocalization condition, 4.73 for the spontaneous mediation condition, and 5.25 for the vocal mediation condition. Duncan's multiple range test was performed to test the significance of the difference between these three means, and it was found that the only two means which differ from each other at the .05 level of significance are those of the vocal mediation condition and the competing vocalization condition. Thus, instructions to vocalize labels for the symbols result in significantly better association recall of the symbols than do instructions to vocalize the months of the year.

2. DSy errors. Relatively few errors were scored using the criteria described in Appendix VIII. Out of the 3,714 DSy responses made by the 180 Ss, 36, or less than 1% of these were errors. Seventeen Ss accounted for all of the errors, and 16, or 94% of them were elderly Ss. Clearly, elderly Ss are more likely to make scorable errors than young adult Ss. Although there were not enough errors for a reliable statistical analysis, a simple frequency count was taken of the number of

Ss making at least one error, categorized by sex and mediation condition. This frequency distribution is presented in Table 27. Note that the number of Ss of each sex who made at least one error was approximately the same, with a possible tendency for males to make more errors than females (10 and 7, respectively). Regarding mediation conditions, there appears to be a trend for fewer errors to be made under the simple spontaneous mediation condition, compared to the vocal mediation condition and the competing vocalization condition (3, 6, & 8 Ss, respectively).

Half of the 36 errors made in the experiment were made by three elderly Ss who made a type of error which can be described as linear copying. Linear copying occurs when the S apparently becomes confused and copies the symbols consecutively as they appear in the code, one after another, without reference to the digits. The other 18 errors were rather evenly distributed among the following categories of errors: wrong symbols, indistinguishable responses, reversals, number copying, intrusions, contaminations and rotations.

3. An age deficit in the recognition of the speed requirement. As was noted in Chapter II, the standardized WAIS DSy instructions do not explicitly direct the S to fill in the squares as quickly as he can. He is simply told to "fill in as many squares" as he can, with a "Ready, begin" and a clicking of the stop watch as implicit indications of the need to

TABLE 27

The Number of Ss Who Made at Least
One DSy Error, Categorized by
Sex and Mediation Condition

Mediation Condition	Male	Female	Total
Spontaneous Mediation	1	2	3
Vocal Mediation	6[a]	0	6
Competing Vocalization	3	5	8
Total	10	7	17

[a] One of these Ss was a young adult. The remainder of the 17 Ss were elderly.

work quickly (Wechsler, 1955). During the administration of the DSy Test to the elderly Ss, the present author made an observation which has not been reported previously to the best of his knowledge. This observation is that the majority of the aged Ss, particularly those over 80 years of age, seemed to be totally unaware of the need for speed. It was not only that they might not have liked to work quickly or merely that they were unwilling to work quickly, or even that they were not able to work quickly. More basically, it appeared to be that they did not even realize that they were supposed to fill in the marks as quickly as they could. As might be expected, upon being interviewed, they often reported that it was the accuracy or quality of their performance that they were most concerned about, rather than the quantity. But beyond this preference for caution and quality as opposed to quantity, many aged Ss also seemed not even to be alert to the implicit speed requirements of the task.

In order to check this observation empirically, an analysis of item number six of the DSy Questionnaire (Appendix VII) was conducted. This item questions the S as follows: "Before the experimenter suddenly directed you to stop working, were you aware that you should work as quickly as possible?" The S is required to reply either "Yes," "Uncertain," or "No." The frequency distribution of "Yes," "Uncertain," or "No" responses to this item for each of the two age samples is presented in Table 28. A complex Chi-Square Test was performed on the data of Table 28, and it indicated that the category of response was significantly related to the age of the _S_ ($p < .001$). In particular as Table 28 suggests, the young adult _S_s most frequently responded that they were aware of the need for speed in DSy performance, while the elderly _S_s most frequently indicated that they were not aware of the need for speed in DSy performance.

What effect did this failure to recognize the need for speed have on the elderly? A _t_ test was performed in order to answer this question. The difference between the DSy means of the elderly who recognized the need for speed and those who did not recognize the need for speed was not statistically significant ($t = .76$). For the young adult sample, however, the DSy mean of those _S_s who report a recognition of the need for speed (61.80) was significantly ($t = 2.23$, $p < .05$) higher than the DSy mean of those who reported a failure to recognize the need for speed (52.62). Thus, for young adults, it appears that ability to recognize the need for speed is directly related to DSy performance.

4. _Separate analysis of the two age samples_. For reasons which are considered further in the following chapter, an alternative mode of analyzing the present experiment would be to

TABLE 28

Frequency Distribution of Ss Responding "Yes," "Uncertain," or "No" to a Question Concerning Their Awareness of the Need for Speed in Their DSy Performance (DSy Questionnaire Item #6)

Age Sample	"Yes"	"Uncertain"	"No"
Young	61	16	13
Old	40	3	47
Total	101	19	60

break it down into two sex by mediation factorial designs, one with a college, young adult sample, and one with an old age sample. The disadvantage of this procedure would be the elimination of the interaction *F* values involving age with the other two variables. However, there is some question as to the effectiveness of statistically adjusting for the level of education covariate (e.g. Winer, 1962) as compared to analyzing each age sample separately. Furthermore, as will be discussed in the next chapter, the phenomenological impact of the three mediation instructions may have been very different for the elderly than for the young.

Within each age sample, level of education was distributed rather homogeneously as indicated by the means listed in Tables 5 and 6 and confirmed by the analysis of variance reported in Table 8. Thus, each age sample could be analyzed independently, with an effective elimination of the confounding variable of level of education. Winer (1962) has suggested that such an experimental elimination of a covariate confound is preferable to statistical control in this kind of situation. Hence, it was decided to analyze the DSy performance of the two age groups separately as a supplementary, alternative method of analyzing the DSy results. Tables 29 and 30 summarize the analysis of variance for the DSy scores of the old age and the young adult samples, respectively. The analysis of variance for the old

TABLE 29

Supplementary Analysis of Variance

Summary for the DSy Scores

of the Old Age Sample

Source	SS	Df	MS	F
Sex (S)	27.78	1	27.78	0.22
Mediation (M)	80.68	2	40.34	0.32
M x S	1524.89	2	762.45	5.97*
Error	10725.94	84	127.69	

* $p < .005$

TABLE 30

Supplementary Analysis of Variance
Summary for the DSy Scores
of the Young Adult Sample

Source	SS	Df	MS	F
Sex (S)	328.69	1	328.69	4.26*
Mediation (M)	2030.82	2	1015.41	13.16**
M x S	2887.01	2	1443.51	18.70**
Error	6483.31	84	77.18	

* $p < .05$

** $p < .001$

age sample reveals that sex and mediation conditions independently had no effect on the performance of the elderly. However, the interaction of these two factors is significant ($p < .005$). For the young adult sample, as indicated in Table 30, all three factors are significant: sex ($p < .05$), mediation ($p < .001$), and the interaction of sex and mediation ($p < .001$). The significant main effect of sex for the young adult sample is due to the superior performance of the females. The main effect of mediation conditions for the young adult sample was analyzed further with Duncan's multiple range test. While all of the DSy means are in the predicted direction, with spontaneous mediation highest, followed by vocal mediation and then by competing vocalization, the range test showed that while the spontaneous mediation condition elicited significantly better performance among the young adults than the competing vocalization condition ($p < .001$) and the vocal mediation condition ($p < .05$), the vocal mediation condition was not significantly higher than the competing vocalization condition ($p < .20$).

Figure 2 presents graphs of the significant interactions between sex and mediation conditions for each age group. For the old age sample, it would appear from Figure 2 that the significant interaction was due primarily to the superiority of females over males in the competing vocalization condition. This advantage of the elderly females over the elderly males in

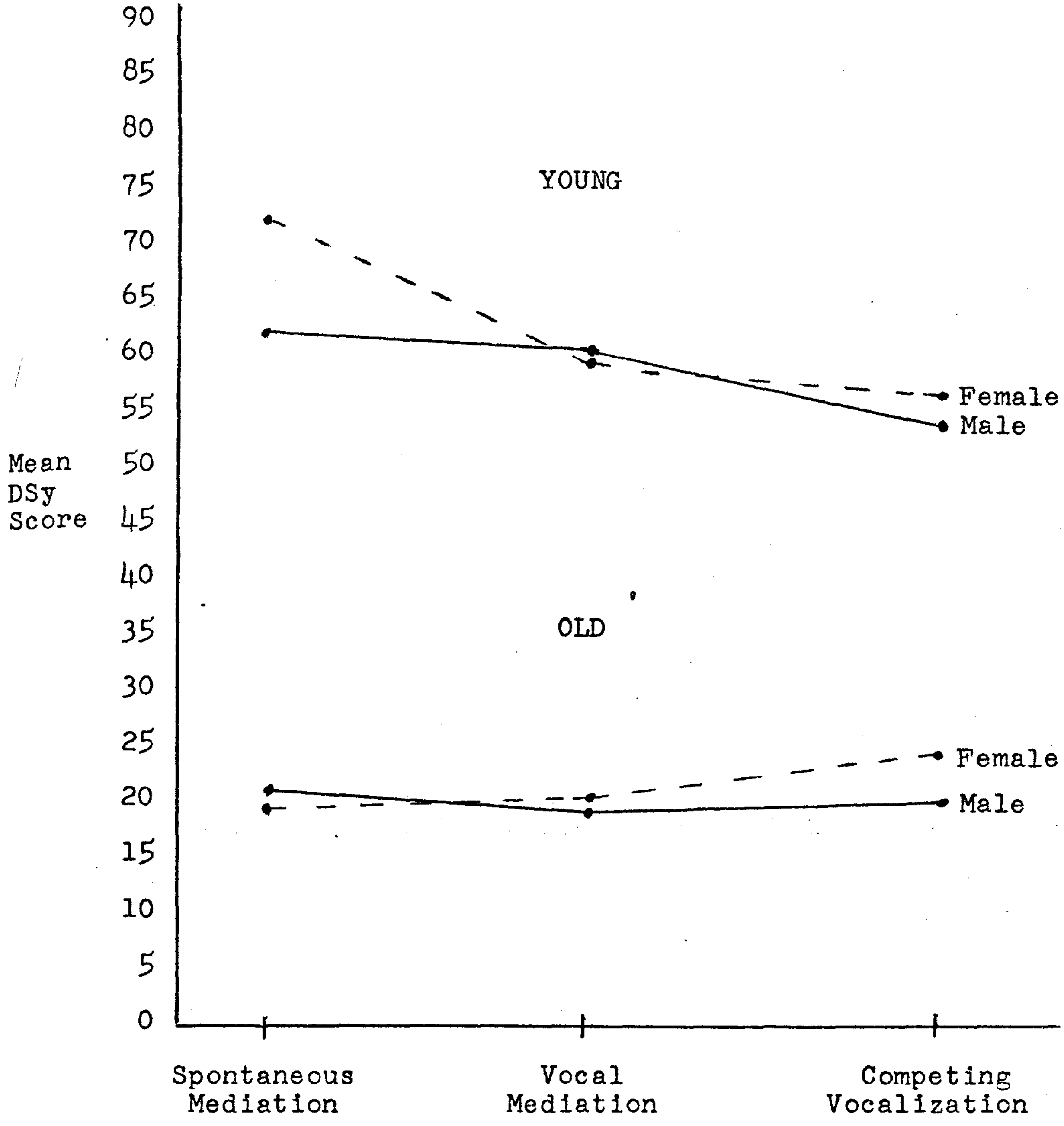

Fig. 2. Graph of the interaction of sex and mediation conditions on DSy performance in each age sample.

the competing vocalization condition cannot be explained away on the basis of the level of education variable since the average level of education in this group was actually slightly, although not significantly, higher among the males (10.20) than among the females (9.60).

The interaction of sex and mediation in the young adult sample as graphically represented in Figure 2 is clearly due to the marked superiority of females under the spontaneous mediation sample. Thus as predicted, the sex difference in favor of young adult females ($\underline{p} < .05$) was markedly reduced by both the competing vocalization condition and the vocal mediation condition. As in the case of the old age sample, the sex by mediation interaction cannot be explained as a function of the facilitating effect of a higher level of education since the mean level of education in the spontaneous mediation condition was actually slightly, although not significantly, higher among the males (14.00) than among the females (13.67).

5. Supplementary analysis of the five secondary hypotheses. The secondary hypotheses were designed to account for or "explain" the hypothesized DSy sex difference in favor of females, assuming that such a sex difference would be found. As we have seen, the sex difference was in the predicted direction, but in the over-all analyses of covariance and variance, the significance of this difference was limited ($\underline{p} < .10$ and $\underline{p} < .20$, respectively). Thus, one possible explanation of the failure

of the secondary hypotheses to be confirmed might be that in this particular sample, there just happened to be no reliable sex difference. This would lead to the conclusion that the secondary hypotheses were not given a fair chance of being confirmed as explanations of the DSy sex difference simply because there was no sex difference to explain. It remains unanswered as to whether these hypotheses would be confirmed in a sample with a large, clear sex difference in favor of females.

The spontaneous mediation groups of young adult Ss in the present experiment constitute such a sample. The mean DSy score of the young adult females in this condition was over 10 points higher than that of the corresponding males, and this difference was highly significant (t = 2.89, df = 28, $p < .01$). Since this was the condition and age group (SM-Young) in which the greatest DSy sex difference occurred, it should constitute the best possible subsample within this experiment for testing hypotheses concerning this sex difference. Accordingly, it was decided to test each of the secondary hypotheses separately for this subsample as a supplementary analysis. As in the analyses of the secondary hypotheses for the total sample, the five highest and the five lowest Ss on each variable in each subgroup were used, and were combined with the corresponding high and low Ss from the other subgroups in order to form the high and the low groups for comparison.

For the hypothesis concerning handedness, however, no statistical test could be performed because there were only two left-handed Ss (both males) in the spontaneous mediation groups of the young adult sample. However, the DSy mean score of these two male left-handed Ss was not much lower than that of the spontaneous mediation male Ss as a whole (60.5 and 61.13, respectively). Therefore, the large difference between the DSy means of the male and female spontaneous mediation Ss (10.47) could hardly have been due to handedness. As for the other four variables involved in the secondary hypotheses, the DSy means of the high and low groups on each variable and the corresponding t values are presented in Table 31. Note that the number of Ss involved in the test for repetitive manual activities are only five high and five low in this variable because only females reported such activities and therefore only females were involved in the analysis of this variable. As Table 31 indicates, none of the t values are significant. Thus, none of the five variables under investigation (verbal mediation, physical difference (weight), handedness, repetitive manual skills, and motivation) were significantly related to DSy performance in this subgroup where the DSy sex difference in favor of females was most pronounced. Finally, an examination of the additional items of the DSy Questionnaire responses for the spontaneous mediation, young adult subsample was made

TABLE 31

DSy Means, n's, and t values for the Supplementary Analysis of the Secondary Hypotheses Using Only the Spontaneous Mediation, Young Adult Subsample

Secondary Hypothesis	n	DSy Mean	t
1. Verbal Mediation			
High Mediation	10	71.00	1.68
Low Mediation	10	63.40	
2. Physical Difference			
Heavy	10	60.60	1.62
Light	10	67.90	
3. Handedness[a]			
4. Repetitive Manual Activities (RMA)			
High RMA	5	69.60	0.06
Low RMA	5	68.60	
5. Motivation			
High Motivation	10	73.70	1.87
Low Motivation	10	65.30	

[a] Only 2 Left-Handed Ss.

in a further attempt to find some explanation for the obtained sex difference. The two items not previously explored, which showed the greatest sex difference were the third and fourth questions.

These DSy Questionnaire Items concerned ratings of the amount of DSy performance time used by the S in attempting to learn the DSy associations (Questionnaire item #3), and the frequency of unnecessary glances at the code key (Questionnaire item #4) after the S was already relatively certain he knew which mark to use. The young female, spontaneous mediation Ss reported significantly less test time used in attempts to learn the DSy associations than the young male Ss in the spontaneous mediation condition ($t = 2.30$, $p < .05$). There was a tendency for males to report more unnecessary glances at the code key than females, but it was not statistically significant ($t = 1.33$). Granted that males spent more time in attempting to learn the DSy associations, is test time spent in attempting to learn the association related to performance? The five highest males and the five highest females in reported time spent in learning the associations were compared with the five lowest males and the five lowest females on this variable, with DSy score as the dependent measure. The resulting mean DSy score of those high in attempted learning (67.20) was almost identical to that of those who were low in attempted learning (67.90). Thus, the supplementary analysis of the additional questionnaire data did not uncover any variable which could adequately explain the DSy sex difference found in the young adult, spontaneous mediation subsample.

CHAPTER V

Discussion

Primary Hypotheses

Primary hypotheses one and four received unequivocal confirmation, and primary hypotheses two and five received partial confirmation only. Primary hypotheses three, six, and seven were not confirmed at acceptable levels of statistical significance, although there were some tendencies in the predicted direction for all hypotheses. Supplementary reanalysis of hypothesis three yielded significant results for the young adult sample when this sample was analyzed separately. Each primary hypothesis is discussed in detail below, with qualifying comments and conclusions based on the supplementary findings included when appropriate.

1. Effectiveness of experimental instructions. As measured by the reported use of verbal mediation (Mediation Use Scale, Appendix VI), all three conditions resulted in significantly ($p < .001$) different levels of verbal mediation, with vocal mediation higher than spontaneous mediation, which in turn was higher than competing vocalization, exactly as predicted. Therefore, it appears that the instructions were effective.

To some extent, the elevation of the verbal mediation scores in the vocal mediation condition probably is exaggerated relative to the other two conditions because _S_s in the other two conditions often seemed not to fully understand the Mediation Use Scale instructions. Occasionally, a _S_, usually an elderly one, would emphatically deny having used labels for the marks, thus obtaining a verbal mediation score of zero, even after he spontaneously vocalized some of the symbols during the practice phase or even during the DSy performance proper. However, the _S_s in the vocal mediation condition almost automatically acknowledged that they used verbal mediation because they had been explicitly taught to do so vocally.

The assumption that _S_s do use verbal mediation spontaneously was supported by the large percentage (61.67%) of spontaneous mediation _S_s who reported using labels for at least some of the symbols. This finding verifies the need for a control condition such as the competing vocalization condition which inhibited verbal mediation which otherwise would have occurred spontaneously in a large part of the sample. Surprisingly, some (31.67%) of the _S_s in the competing vocalization condition nevertheless reported at least some use of verbal mediation. In the majority of these cases, the author is inclined to believe that the _S_'s report of his own mental behavior was erroneous or that he simply failed to make the fine distinction between being conceptually aware of the meaning of a symbol and actually verbalizing it mentally, that is, subvocally. However, it is possible that in between vocalizations of the months, some Ss were able to subvocally verbalize the labels for the symbols.

2. Facilitating effect of verbal mediation. For the hypothesis concerning the predicted facilitating effect of verbal mediation, partial confirmation was obtained. The main effect of verbal mediation on DSy performance was significant in both the analysis of covariance ($p < .025$) and the analysis of variance ($p < .05$), but the effect of mediation condition was found to depend upon the age of the S. Thus, the mediation by age interaction, significant in both the analysis of covariance ($p < .005$) and the analysis of variance ($p < .01$), was graphically presented in Figure 1. As the significance of the interaction implies and as the examination of Figure 1 reveals, the facilitating effect of verbal mediation was confirmed for the young adult sample, but not for the old age sample. For the young Ss, spontaneous mediation was the most facilitating condition, followed by the vocal mediation and competing vocalization conditions in the predicted order. It was the superiority of the spontaneous mediation groups over the competing vocalization groups among the young adult sample which contributed most to the significance of the mediation variable.

Thus, the use of verbal mediation, natural and most effective in the spontaneous mediation condition and inhibited in the competing vocalization condition, clearly results in superior DSy performance among the type of young adult college students employed in this study. Training the Ss to vocalize verbal labels for the symbols is not as facilitating as simply allowing them to use their own verbal mediation processes spontaneously, because the former requires conscious effort, and in this study, a need to vocalize the labels instead of just "thinking" of them naturally. The latter is automatic when it occurs, and is not a requirement of acceptable performance. Therefore, the spontaneous mediation S has no need to stop and try to remember the appropriate label when it does not come to mind spontaneously. The vocalization of the mediating labels not only takes longer, but it may be facilitating only with those symbols which are most conducive to labeling.

But why was the hypothesis of the facilitating effect of verbal mediation confirmed only for the young adult sample? Why didn't the vocalization of labels for the symbols improve the DSy performance of the aged as predicted? One possible reason is that the elderly Ss often had special difficulty remembering the proper label for some of the symbols. Thus, a longer training session may be needed for these Ss. More elderly Ss (36.67%) than young adult Ss (3.33%) needed assistance in labeling at least one of the symbols. Therefore, the appropriate label did not come to mind as easily for the aged as for the young Ss. Being required to vocalize the label might therefore have delayed rather than facilitated the DSy performance of the elderly. Apparently, the practice session was not long enough for the elderly to consolidate their memory of the labels, given the more complicated demands of the actual DSy Test. The underlying assumption of the facilitating effect of vocal mediation was that the vocal mediation instructions and practice would help the elderly to overcome an hypothesized deficit in verbal mediation ability. Although the deficit appeared to be verified, and it appeared to be reduced through practice, the requirement to vocalize the labels possibly cancelled out the benefit achieved through the mediation instructions and practice.

Granted that this is a plausible explanation for the failure of the vocal mediation instructions to facilitate DSy performance among the elderly, why did the Ss in the competing vocalization condition manifest a slight tendency to do better than the other elderly Ss? Just as those in the spontaneous mediation condition, these Ss also had to make deliberate vocalizations which might require extra time and effort. Why should this condition have been more facilitating, though insignificantly so, than the spontaneous mediation condition among the elderly?

Here is where some clinical observations proved to be important. It was observed that in both age samples, Ss tended to vocalize one month per response. More often than not, Ss in the competing vocalization condition vocalized a month (the competing vocalization) and drew a symbol at the same time, establishing a vocal-motor rhythm or tempo of one response per vocalization. Since young and old alike found it easier and faster to say the months of the year consecutively and repeatedly than to draw the appropriate symbols in the appropriate squares, their speed and rhythm of saying the competing vocalization perhaps influenced the speed and rhythm of their DSy responses. Of course, this same kind of DSy response and vocalization correspondence in timing of responses appeared to occur also among the Ss in the mediation conditions. But in these conditions, there was no apparent tendency for labels to be vocalized more easily or quickly than they were drawn. More concisely, the Ss under the competing vocalization condition may have timed their responses to the speed of their vocalizations. Thus, the old age Ss, who seemed to know the months of the year as well as the young adult Ss, may have set a faster tempo for their responses, relative to the other elderly groups, because of their tendency to say the months of the year more quickly than they could draw the marks. In effect, they had to hurry their DSy responses in order to keep up with their months of the year responses. In the young adult sample, the competing vocalization condition did not have the same advantage for the Ss since their DSy responses were naturally more rapid anyway, and thus they more easily kept up with the tempo of their competing vocalizations. The reader can demonstrate this to himself by saying the months of the year consecutively, over and over again. Is not your speed of saying the months greater than the speed at which you would be able to draw the appropriate symbols for each digit presented in the DSy Test? Therefore, while the competing vocalization might have competed with the appropriate symbol vocalization for such _S_s, the ordinarily slow working elderly _S_s were perhaps actually speeded up by the competing vocalization of the well known months of the year, thus speeding up the symbol-vocalization tempo.

But why do the elderly _S_s ordinarily tend to perform slowly on the DSy Test? Many of these _S_s spontaneously commented that they would rather do an accurate job than perform quickly. They tended to perceive their task as merely to fill in the squares correctly, often without any apparent recognition of the need for speed. Obviously, they could not work as quickly as younger _S_s, but beyond that, there seemed to be a more basic failure in their apparent alertness to the implicit speed instructions which indicate to the _S_, with a clicking of the stop watch: "fill in as many squares as you can without skipping any. Ready, begin (Wechsler, 1955, p. 44)." That is, not only did they appear to be less capable or willing to work as quickly as the younger Ss, but they often did not even appear to recognize that they were supposed to work quickly. As reported in the Results Chapter, item number six of the DSy Questionnaire was analyzed, and it was found that the elderly Ss were significantly inferior ($p < .001$) to the young adult Ss in the awareness that speed was required in their DSy performance.

Thus, to a large extent, the inferior performance of the elderly Ss, particularly without the speed stimulating competing vocalization instructions, was perhaps due to the fact that they simply were not even aware that they should work quickly. An attempt to relate recognition of the need for speed to DSy performance among the elderly yielded a nonsignificant difference in favor of those who were aware of the need for speed. Among the young adults, this difference was significant ($p < .05$). While various interpretations of this finding are possible, the author favors the assumption that the elderly Ss had more difficulty recognizing the need for speed, which was his clinical observation, and that this resulted in poorer performance. The failure of the elderly who recognized the need for speed to be significantly higher in DSy score than the elderly who did not recognize the need for speed, is tentatively assumed to be due to the unreliability of the questionnaire item among the old. This difference was found to be significant among the young, presumably because they were more reliable respondents to the questionnaire items. This hypothesis will certainly remain tentative until tested in future research designed for the specific purpose of testing this "recognition of the need for speed" hypothesis.

A final consideration regarding the failure of verbal mediation to significantly effect the DSy performance of the elderly involves Cohen's (1957, p. 206) conclusion, based on factor analytic studies, that "the specific ability demanded by Digit Symbol at other ages ceases to be important in senescence...." It may be that verbal mediation, important among the young adult sample in this study corresponds to Cohen's (1957) specific factor which loses its importance among aged <u>S</u>s.

3. <u>DSy superiority of females</u>. The hypothesized DSy sex difference in favor of females was not confirmed at an acceptable level of significance, but females did perform better than males. The failure to obtain a significant difference on the sex variable is not unusual. This sex difference is relatively small, and while females almost always score higher than males, statistical significance is not always obtained.

4. <u>DSy old age decrement</u>. The hypothesis of the DSy superiority of the young over the old was overwhelmingly confirmed ($p < .001$). This is consistent with previous research

(Berkowitz, 1953; Botwinick & Birren, 1951, 1963; Chesrow, Wosika, & Reinitz, 1949; Doppelt & Wallace, 1955; Eisdorfer & Cohen, 1961; Fox & Birren, 1950; Madonick & Solomon, 1947; Norman & Daley, 1959; Rabin, 1945; Wechsler, 1958), and is undoubtedly due to a multiplicity of factors such as deficits in motivation, perception, education, and speed (Geist, 1968). Inasmuch as the age decrement was highly significant even with level of education controlled as a covariate ($p < .001$), it is clearly not explainable solely as an educational confound.

The tendency for older _S_s to be apparently unaware of the need for speed has already been discussed. This tendency perhaps can account for part of the variance due to age, and it is especially significant because this seems to be the first time it was identified as a likely determinant of the DSy decrement. Another possibly new determinant of the age decrement also was discovered by clinical observation of the aged _S_s in this study. It was noted repeatedly, especially among the more debilitated _S_s, that the elderly were confused by the final phase of the instructions. Recall that in the standard DSy instructions (Appendix I), the _S_ is asked to do the practice items: "Now you do it for these numbers as far as this line (Wechsler, 1955, p. 44)." Whereas the young _S_ stops at the indicated line and awaits further instructions, many aged _S_s do not stop themselves as directed. They proceed to begin to fill in the first item of the test proper, and are prevented from doing so only by the E who must hastily remind them to stop or "pause" at the line. Having just been told to stop, the elderly S is then given the remainder of the instructions: "Now when I tell you to begin, start here and fill in as many squares as you can without skipping any. Ready, begin (Wechsler, 1955, p. 44)." These "begin-stop-begin" instructions confused many elderly Ss. While they may have been doing well on the practice items, they seemed to forget what it was they were doing once they were told to stop. When they were told to begin again, many of them started very slowly on the performance proper—more slowly than they had performed on the practice items.

5. Verbal mediation by age interaction. It was hypothesized that the verbal mediation by age interaction effect would be significant, and indeed it was, both in the analysis of covariance ($p < .005$) and the analysis of variance ($p < .01$). However, the hypothesis can be considered only partially confirmed at best. It was expected that the age difference would be reduced under competing vocalization instructions because it would take away some of the young adult advantage in mediation skill. This was confirmed, as indicated in Figure 1. It was also expected, however, that the vocal mediation instructions would reduce the age difference relative to the spontaneous mediation condition by improving the performance of the elderly while

slightly hindering the performance of the young. As Figure 1 indicates, the vocal mediation condition did reduce the age difference, but only by reducing the level of young adult performance rather than also significantly improving the performance of the aged. Furthermore, the age difference was reduced more, relative to the spontaneous mediation sample, under the competing vocalization condition than under the vocal mediation condition. The specific departures from the predicted results were due primarily to the failure of the vocal mediation condition to significantly improve DSy performance and secondarily to the slight tendency for the old to do even better instead of worse under the competing vocalization condition. The reasons for these departures from the predicted findings have already been discussed with reference to primary hypothesis number two.

6. Verbal mediation by sex interaction. The hypothesis that the DSy superiority of females would be reduced by the competing vocalization instructions and to a lesser extent by the vocal mediation instructions was not confirmed. While the young adult females did appear to lose their advantage under the competing vocalization and vocal mediation conditions as expected, the elderly females tended to do even better under the competing vocalization condition. Since the relevant three-way interaction was not significant ($p < .20$), the assumption that this trend was due to chance seems most tenable.

7. Age by sex interaction. The hypothesis that the DSy sex difference would be of lesser magnitude among the old than among the young was not confirmed at an acceptable level of statistical significance. However, in the spontaneous mediation condition, the sex difference was considerably greater among the young than among the old (9.68 DSy raw score points). Thus, the predicted age by sex interaction may occur in this condition, but not in the others. Even though the relevant three-way interaction was not highly significant ($p < .20$), it may be that under directions which are similar to the standard instructions (spontaneous mediation condition) this age by sex interaction hypothesis has some validity, but it must be retested in future research for confirmation.

Supplementary, Separate Analysis of the Two Age Samples

Some authors such as Winer (1962) question the adequacy of using analysis of covariance to adjust for initial biases on the covariate when the difference between the covariate means are relatively large. However, this kind of adjustment was attempted in this study because the difficulties involved in assessing the effects of age independent of level of education (Anastasi, 1968) make experimental control of level of education extremely difficult to achieve. Even if one were able to equate level of education across age groups by selecting only the elderly who have a history of some college education, this could introduce other selection biases of an unknown nature. The average students who were able to attend college 30 or 40 years ago when only the socially and economically elite usually were able to attend college must surely have differed in many ways from today's students whose backgrounds are far more diverse.

An alternate method of analysis which was described in the last chapter is to analyze each age sample separately as if the study involved two experiments, each involving 90 Ss and two independent variables: sex and verbal mediation. This method of analysis seems appropriate not only because of the covariate considerations discussed above, but also because of the different ways in which the mediation conditions affected each sample. The competing vocalization condition constitutes a prime example of this. Given the relatively rapid DSy performance of the young adults, the competing vocalizations probably did interfere with subvocalization of the symbol labels. On the other hand, given the relatively slow tempo of the typical aged S, it was easy for him to vocalize the months of the year and still have plenty of time in between these vocalizations to say the symbol labels mentally.

With these considerations in mind, the separate analyses of variance, summarized in Tables 29 and 30, were conducted. The only significant effect thus obtained for the elderly Ss, the mediation by sex interaction ($p < .005$), has been attributed mainly to the superiority of the elderly females over the elderly males in the competing vocalization condition. It may be that while this condition may not have interfered with spontaneous mediation among the old, it did speed up the tempo of responses among the females. Perhaps, the same effect did not occur for the males because they were not verbally facile enough to vocalize the months of the year while also vocalizing the symbol labels silently.

The results of the supplementary analysis of variance for the young adults (Table 30) were significant for sex ($p < .05$), mediation ($p < .001$), and the sex by mediation interaction ($p < .001$) as predicted in the original, primary hypotheses. Thus, for young adults, females tend to be superior to males in DSy performance, and the natural spontaneous use of verbal mediation is most effective, followed by the vocal mediation and competing vocalization conditions, as predicted. The sex by mediation interaction, while significant, was slightly different than predicted. The sex difference was decreased by the requirement to vocalize the months of the year because this interfered or competed with the use of verbal mediation which is hypothesized to account for much of the female superiority in DSy performance. This finding supports the hypothesis that the DSy sex difference is at least partly due to the feminine facility in verbal mediation—their ability to efficiently translate the visual-motor task into a verbal one. However, the vocal mediation condition reduced the sex difference, not by helping the males to compensate for their hypothesized relative lack of verbal mediation ability, but apparently by slowing up the performance of the female Ss. Having to vocalize each label may make their hypothesized natural subvocalization of labels more deliberate, artificial, and ineffective. This may be why the vocal mediation instructions did not produce significantly better performance than the competing vocalization condition, as assessed by the range test analysis ($p < .20$).

Secondary Hypotheses

Of the five variables involved in the five secondary hypotheses, the only one which was significantly related to DSy performance was "motivation," and this was significant only for the young adult sample ($p < .02$). Because only one out of the nine t tests that were involved in testing these variables (Tables 19 and 20) was significant, one could well object that one out of nine t tests will be "significant" at the .02 level by chance in approximately one out of every five such replications of an experiment. Thus, one can hardly conclude that for young adults self-reports of high motivation are related to superior DSy performance. It should be remembered, however, that the secondary hypotheses are purely exploratory and are designed merely to point out the most promising hypotheses for future research.

1. <u>Verbal mediation and sex</u>. The finding that reported verbal mediation was not significantly related to DSy performance conflicts with the results of the main analysis in which the effect of verbal mediation instructions upon DSy performance was significant in the analyses of variance ($p < .05$) and covariance ($p < .025$). This could suggest that: (*a*) *S*s are not reliable informants concerning their use of verbal mediation; (*b*) the Mediation Use Scale is not a satisfactory measure of verbal mediation; (*c*) the three conditions had effects upon DSy performance which were independent of the amount of verbal mediation which they elicited, or (*d*) all or some combination of the above explanations may be true. More fundamentally, however, it may be the qualitative rather than the quantitative aspects of verbal mediation which may be most significant. The number of symbols labeled (Mediation Use Scale) may be less important than the speed and skill with which a *S* labels each symbol, although these latter factors may prove to be more difficult to measure. While the predicted tendency for females to obtain higher reported levels of verbal mediation reached only suggestive levels of significance in the analyses of variance ($p < .20$) and covariance ($p < .10$), a measure of verbal mediation skill also might have yielded a clearer advantage for the females.

2. <u>Physical difference and sex</u>. The finding that body weight, used as a measure of "delicacy of physique," was not

significantly related to DSy performance for either age group was not altogether unexpected because it is a relatively gross physical difference measure. More refined measures may yet be found which could be related to both DSy performance and sex, thus accounting for the DSy sex difference. However, the present author's own assumption is that the DSy sex difference is due to more than differences in physique. Perhaps the most interesting aspect of the data on this hypothesis is that, as indicated in Tables 19 and 20, there was a tendency for the variables of age and reported weight to interact. The heaviest of the elderly _S_s and the lightest of the young adult _S_s tended to obtain the highest DSy scores. Among the young, the "delicacy of physique" hypothesis (Gari & Scheinfeld, 1968) may have some validity, but among the aged, some of the lightest _S_s are those whose physical condition is most deteriorated, while those who still have a good appetite and are heavier may tend to be the healthiest and best functioning.

3. "Crabbed" handedness and sex. McCarthy's (1961) hypothesis that the DSy superiority of females is merely an "artifact" of handedness rests on two assumptions, the first of which has received some experimental support (Bonier & Hanley, 1961). The first assumption is that "crabbed" handed _S_s perform more poorly on the DSy Test, and the second assumption is that there are fewer "crabbed" handed females than males.

The first of these assumptions received more support in the present study than the second assumption did. There was a tendency for left-handed Ss in general, both the "crabbed" and the conventional in handwriting style, to do more poorly than right-handed Ss. Although the difference was not significant, it was large enough that, given a larger sample of left-handed Ss, a significant effect of handedness might emerge. Where McCarthy's (1961) hypothesis did not hold up at all, however, was in his assumption that more males than females are left-handed and "crabbed" handed. Out of the 10 left-handed young Ss, half were males and half females. Four out of the five females were "crabbed" handed while only two out of the five males were "crabbed" handed. Thus, if anything, it was the females rather than the males who were most handicapped by this style of writing. While handedness and writing style may affect DSy performance, it cannot account for the DSy superiority of females. Even if there were more "crabbed" handed males than females, it seems doubtful that there would be enough of these Ss in most samples to account for a significant sex difference.

It should be noted that since only one of the 90 elderly Ss was left-handed, the effect of handedness among the aged could not be assessed, even tentatively. One might hypothesize that the rarity of left-handedness in this group was due to a tendency, years ago, for parents to actively discourage children from being left-handed. With the increased education and permissiveness of more recent decades, parents are more likely to allow their children to be left-handed when this develops naturally.

4. Repetitive manual skills and sex. It was clear from the start that females would report higher scores on this variable than males. Not a single male reported any significant amount of sewing type activities except for occasionally sewing a button onto a shirt. More importantly, the crucial question was, independent of sex, do repetitive, fine motor skills such as those mentioned in item 13 of the DSy Questionnaire transfer to the DSy Test situation? As indicated by the data of Tables 19 and 20, not only was DSy performance unrelated to the time females spent in such repetitive manual activities, but if anything, it seems that those who spend little or no time in these activities tend to perform better on the DSy Test. Therefore, this hypothesis for explaining the DSy sex difference does not seem to warrant further consideration. It may be that those who sit and spend much of their time in this anxiety reducing activity are those who tend to avoid more productive activities.

5. Motivation and sex. Since "motivation," as measured by the simple rating scale of questionnaire item number five (Appendix VII) was the only one of the secondary hypotheses to

be confirmed ($p < .02$) at least for one age group (young adults), it is perhaps the most promising of them, and therefore warrants additional experimental attention. The finding that among the young adults, DSy performance is directly related to the motivation of the S is a confirmation of the previous research by Oakland (1969), although he defined motivation differently and employed the WISC Coding version of the DSy Test. Since the DSy Test is conceptually simple and so dependent on speed and motor "work," the harder a S tries, the better he tends to do. This may be true of most tests, but it seems to be particularly true of the DSy Test.

Why didn't this same relationship hold for the old age sample? The aged who reported that they expended considerable effort on their DSy performance actually tended, if anything, to perform more poorly than their less "energetic" associates. Why this difference between the two age groups? It appears quite likely that the aged Ss interpreted this item differently from the young adult Ss. Some aged Ss, who often needed help responding to the questionnaire items, seemed to interpret the "how hard did you try to do your best" aspect of the question as if it read, "How hard was this task?" Assuming this interpretation of the item, the aged Ss who had the most difficulty in this DSy performance would report high "motivation" or effort scores and would score more poorly than those who did not find the task difficult or "hard." Thus, the elderly who obtained high "motivation" scores may actually have been reporting that they found the DSy task to be very difficult. Therefore, this item may have measured something quite different for each age sample.

Even though the motivation item was the only one of the secondary hypotheses to receive any significant confirmation, it cannot be used to account for the DSy superiority of females, because among the young, whose performance was directly related to motivation level, the males reported more motivation than the females ($\underline{p} < .10$). Analysis of the spontaneous mediation, young adult sample, for the five secondary variables (Table 31) and for the other questionnaire items similarly failed to uncover any variable which was both related to DSy performance and which also differed significantly on the sex variable, even though the sex difference in this particular subsample was quite pronounced ($\underline{p} < .01$). Either the factor responsible for the usual DSy sex difference has not yet been identified, or it is multi-determined to the extent that one single factor is unlikely to be significant except in an extremely well controlled study.

Association Recall

As in the study by Koestline and Dent (1969), DSy association recall scores were significantly affected by the mediation conditions, and this was found in the analysis of variance

($p < .025$) as well as in the analysis of covariance ($p < .005$). The ability of the Ss in the vocal mediation condition to remember the symbols and to correctly match them with the proper digits was undoubtedly due to the addition of a meaningful verbal component to the memory of the symbol. If the S's visual memory of a symbol failed him, he could still think of what it was, in terms of the label assigned to it, and from this he could reconstruct what it looked like.

The finding that the young adult Ss correctly recalled more DSy associations than the elderly Ss ($p < .001$) was to be expected because of the decrements in memory which occur normally in old age. In fact, it is perhaps surprising that the difference was not even greater, considering that the elderly Ss averaged more than 80 years of age compared to the young adults who on the average were a little over 21 years of age. Very often, the elderly Ss swore that they could not remember any symbols, but after encouragement, most of them obtained some correct responses. Characteristically, the aged Ss did not want to make a response unless they were sure that it was correct.

DSy Errors

The finding that less than 1% of the DSy responses were errors is not surprising in view of the traditional emphasis on the DSy Test as a test of quantitative rather than qualitative performance. As indicated in the DSy Scoring Guide

(Appendix VIII), the usual criteria for scoring a response as correct are quite broad and liberal. The finding that elderly Ss are more likely (16:1) than young adult Ss to make an error is not very surprising, either. Aged Ss such as these are often handicapped by visual, motor, and mental deficits, especially those who resided in an "old age home" as opposed to the more independent senior citizen's community in Mayslake. It is probably because of such deficits that elderly Ss tend to compensate by being so careful, slow, systematic, and even overly cautious in their performance. A DSy error, because of its rarity, may be an important diagnostic sign of organicity or other syndromes. Sex and mediation condition apparently had no important effect on scorable DSy errors.

Conclusions

1. Spontaneous verbal mediation. A majority of Ss employ verbal mediation to some extent, usually subvocally, even when they are not directed to do so. Thus, any study such as that by Koestline and Dent (1969) which compares a verbal mediation condition to one or more conditions which do not involve verbal mediation instructions must assess and allow for the spontaneous use of verbal mediation in its so-called "control" groups.

2. Verbal mediation ability and age. Aged Ss do retain the ability to use verbal mediation, whether they are allowed to do so spontaneously, by instructions, or even contrary to

the intent of instructions designed to inhibit verbal mediation. However, as indicated by their more frequent need for assistance in thinking of labels for the symbols in the vocal mediation condition of this study, elderly Ss are not as skilled at verbal mediation as are young adult Ss. Inasmuch as verbal mediation does enhance DSy performance, the moderate decrement in the verbal mediation skill of the elderly can be added to the list of factors which may contribute to the DSy old age decrement.

3. Facilitating effect of verbal mediation. The use of verbal mediation does facilitate DSy performance among the young, but its effect upon the DSy performance of the aged is questionable. Among the elderly, the competing vocalization instructions of the present study probably did not greatly inhibit verbal mediation as intended because the relatively slow tempo of the DSy performance of these Ss permitted subvocalizations of symbol labels, alternating with the competing vocalizations. Thus, experimental refinements will be needed to adequately test the effect of verbal mediation upon the DSy performance of elderly Ss.

4. Verbal mediation and sex. In the main analysis, the predicted mediation by sex interaction was not significant, but in a reanalysis of the young adult sample considered separately, it did reach an acceptable level of statistical significance. The sex difference in favor of females in the spontaneous

mediation condition was markedly reduced by both the competing vocalization and the vocal mediation conditions. Thus, the spontaneous use of verbal mediation may account to some extent for the usual sex difference in favor of females. While both males and females use verbal mediation, it is likely that females are more skilled in its use.

5. New hypotheses concerning the DSy old age decrement. Two likely causes of the DSy old age decrement were discovered which apparently have not been reported in the literature. The first of these may be called the "awareness of the need for speed" hypothesis. It appears that one of the reasons for the slow performance of aged *S*s is that they fail to recognize that speed is desirable in DSy performance. It is not only that they are less able or less willing to work quickly. They often are not even aware of the need for speed in DSy performance. Many of the elderly seem neither to pay attention to the implicit speed instructions, nor to notice the stop watch which is used by the *E*.

The second newly discovered factor in the DSy old age decrement is the confusing nature of the "begin-stop-begin" DSy instructions. When the *S* is asked to do the sample items, he is told to stop at the line indicating the end of the sample items. Then he is given final instructions and asked to begin again, this time on the actual test items. Elderly *S*s often seem either to pay no attention to the instructions to stop at the end of the practice series, or to forget about these instructions. When reminded to stop, they are apparently surprised, and when they are immediately given the final instructions to begin the performance proper, they seem to become confused and proceed more slowly than before.

6. DSy sex difference. None of the supplementary hypotheses concerning the DSy sex difference are sufficient individually to account for the DSy superiority of females. At this point, verbal mediation speed and skill, as opposed to the mere use of verbal mediation may be the most profitable direction for future research into the DSy sex difference. In fact, this may also be applicable to the DSy old age decrement. One possible approach to measuring verbal mediation speed would be to administer a series of other symbols, requiring the S to vocalize what they are, or label them, as quickly as he can. A feasible measure of verbal mediation skill might involve rating both the appropriateness and the brevity of the symbol labels employed.

7. Association recall. Spontaneous verbal mediation facilitates recall of the DSy associations. While the aged are handicapped in DSy recall ability, their deficit is perhaps not as great as might be expected. To some extent, such memory deficits in the aged may often appear more severe than they are

because of the usual unwillingness of these Ss to respond unless they are sure that they are correct.

8. DSy errors. Elderly Ss make more DSy errors than young Ss, although DSy errors are relatively rare even among Ss in their 70's, 80's or 90's. The number of errors among the elderly are very clearly not great enough to account for the huge DSy age decrement to any appreciable extent. Because of their rarity, DSy errors may have a useful diagnostic significance which warrants further investigation.

Directions for Future Research

This investigation has advanced the study of verbal mediation and DSy performance well past that of Koestline and Dent (1969) whose pessimistic conclusion regarding the utility of the verbal mediation construct in DSy performance was unwarranted. Their failure to obtain significant effects due to verbal mediation was due to their inappropriate operational definition of verbal mediation and their failure to control for the spontaneous use of verbal mediation as was done in the present study.

Koestline and Dent (1969, p. 378) concluded in part: "If verbal factors are involved, the simplicity of the associations required in DS performance probably is such that any verbal effect is insignificant." Implicit in this assertion, perhaps, is a suggestion that even if verbal mediation or some other verbal process were involved in DSy performance, it would be of no consequence because of its simplicity. That is, if the verbal process is so elementary that nearly everyone could accomplish it with no difficulty, then it is of no psychological interest or practical significance. Since a majority of Ss in the spontaneous mediation condition of the present study either reported using verbal mediation subvocally or were observed to use it vocally at least on some items, it could be asked whether it is of any practical significance.

The likely answer to such a question would have to be affirmative for at least two important reasons. Firstly, the mean number of symbols reportedly labeled by the Ss (Mediation Use Scale) was approximately five out of the total of nine symbols. This is far less than what would be expected from the universal use of verbal mediation. Therefore, everyone does not use verbal mediation on all of the symbols, even if it may be a simple process. Among the aged, it clearly is not simple since some Ss could not think of labels for certain symbols even when they were explicitly directed to do so. Secondly, it seems unlikely that all Ss who do use verbal mediation use it with equal facility. It was observed in this study that there was considerable variability in the speed with which Ss could think of labels. Furthermore, there was an important variability in the simplicity and appropriateness of the labels chosen by different Ss. For example, it would obviously be easier and faster to say to one's self, "dash" than it would be to say "horizontal line," "minus sign," or "the number one on it's side."

Thus, verbal mediation skill and speed may be even more predictive of DSy performance than the mere use or disuse of verbal mediation. The measurement and control of these subtle aspects of verbal mediation will require difficult experimental refinements, but in the present author's opinion, future research would be far more productive if it were directed in that manner.

Another refinement worth consideration in future research would be to examine the effect of other forms of mediation. For example, the only S in the present study to correctly complete all of the 90 DSy items used a complex mediation which was discussed in the review of the literature and which was earlier described by Luchins and Luchins (1953). It involves relating the shape of the digit to the shape of the symbol. For example, upon seeing the digit "6," the S recalls that the symbol for the digit "6" is the bottom circle of this digit. Still another type of mediation would be to conceptualize a symbol in terms of one of its meanings, but without mentally verbalizing the label subvocally. That is, perhaps some Ss could just think of the "X" symbol as a multiplication sign without really using the words "multiplication sign" vocally or subvocally. This kind of distinction may be too subtle to measure or control, and it presents a difficult problem of introspection to even know when we think "in language," as it were, and when we don't. How do deaf and dumb Ss think and "mediate" on the DSy Test? Are there Ss who use a visual mediation? If so, would this really be a mediation at all since the symbols themselves are already presented visually? Such questions as these, as well as the many hypotheses presented in the context of the review of the literature, make the DSy Test an interesting and productive focus for future research.

CHAPTER VI

Summary

This dissertation was based on an extensive review of the litterature on the Digit Symbol (DSy) Test. The review of the literature led to the identification of numerous variables related to DSy performance, some of which were selected for experimental investigation in the present study. Specifically, this study was designed to clarify the effects of age, sex, and verbal mediation on the DSy Test. In this study, verbal mediation was defined as the use of descriptive, verbal labels for visually perceived symbols. These labels supplement or supplant a purely visual memory of the symbols. For example, when the S looks up to the code key in order to locate the appropriate symbol for the digit number one, and he sees the horizontal line which is the symbol, he may say to himself, "dash." Such verbalization usually occurs subvocally.

In addition to the main hypothesis that the use of verbal mediation enhances DSy performance, it was also asserted that the verbal mediation construct could be used to help account for the DSy old age decrement and the usual DSy sex difference in favor of females. It was hypothesized that the mediation by age interaction and the mediation by sex interaction would each be significant. Specifically, it was thought that young adults would be more skilled at the use of verbal mediation, so that instructions designed to facilitate verbal mediation would help elderly Ss more than young adult Ss who would already be using verbal mediation extensively. It also seemed plausible that the verbal mediation condition would similarly reduce the DSy sex difference by helping males more than the already skillful females.

In order to control for the likely spontaneous use of verbal mediation among those Ss not receiving verbal mediation instructions, a competing vocalization condition was employed. This condition was designed to keep the S from using verbal mediation by requiring him to repeatedly vocalize an over-learned series of 12 words, the months of the year. A spontaneous mediation condition was also utilized. In this condition, the S was given instructions comparable to the standard DSy instructions. It was hypothesized that the Ss in this condition would do best of all because they would use verbal mediation spontaneously, subvocally, and without any time consuming, deliberate intention to do so.

In order to assess the effects of age and sex in interaction with verbal mediation, 90 aged Ss at various levels of functioning and 90 college students were used as Ss, half of each age group being males and the other half females. The resulting experimental design was a 2 x 2 x 3 factorial design involving two levels of age, two levels of sex, and three levels of verbal mediation. A total of 180 Ss participated in the study, 15 Ss in each cell of the factorial design. Each S was randomly assigned to one of the three mediation conditions and was given the special instructions and practice for that condition. Then the Wechsler Adult Intelligence Scale DSy Subtest was administered, and was followed by a "Mediation Use Scale" to measure the extent to which the Ss reportedly used verbal mediation, regardless of which condition they received. This was followed by a "DSy Questionnaire" which was used to collect a wide range of secondary, exploratory data.

Because the two age groups differed greatly in level of education, this variable was used as a covariate in a 2 x 2 x 3 analysis of covariance in addition to the 2 x 2 x 3 analysis of variance of DSy raw scores. The same results were obtained, but with more extreme levels of significance in the covariance analysis.

The results of the analysis of variance of DSy raw scores indicated that verbal mediation is a significant factor in DSy performance ($p < .05$). As predicted, the spontaneous mediation condition resulted in the highest DSy mean score, followed by the vocal mediation and competing vocalization conditions, in that order. However, examination of the significant age by mediation interaction ($p < .01$) indicated that the significant main effect of verbal mediation was due to the performance of the young adult sample only. The assumed DSy superiority of the young over the aged was clearly confirmed ($p < .001$). The predicted reduction of the old age deficit under the vocal mediation and competing vocalization conditions was confirmed ($p < .01$), but it occurred mainly by reducing the performance of the young under the vocal mediation condition and especially under the competing vocalization condition. The vocal mediation condition did not greatly improve the performance of the elderly relative to the spontaneous mediation condition. Various explanations for this were discussed.

Two new possible determinants of the DSy age deficit were identified. One involves the tendency for aged Ss to fail to recognize the need for speed in DSy performance, and the other concerns the confusion which these Ss experience when they are told to stop after the practice items, and then are told to start again in the performance proper.

The predicted reduction in the sex difference under the vocal mediation and competing vocalization conditions did not occur at an acceptable level of significance. However, when the confounding effect of level of education was removed by analyzing the two age groups separately, the predicted results were obtained. The uncertain adequacy of the adjustment for the effect of the covariate was one of the factors which suggested the need for a separate analysis of each age sample. In this supplementary analysis, the effects of verbal mediation ($p < .001$), sex ($p < .05$) and the mediation by sex interaction effect ($p < .001$) were all significant for the young adult sample as predicted, but only the effect of the mediation by sex interaction was significant in the old age sample ($p < .005$).

Numerous variables were examined in an attempt to find other factors which might account for the usual DSy sex difference, but none were substantiated. The effects of age, sex, and verbal mediation on DSy association recall were examined, and it was found that spontaneous mediation facilitates DSy association recall, that there was no sex difference in this kind of recall ability, and that aged Ss did have less accurate recall than young adults. They also made more errors than young adult Ss, even though a very small percentage of Ss made any scorable errors at all. In this context, more explicit criteria for scoring DSy errors were presented.

Promising directions for future research were suggested. Prominent among these are variables such as speed or skill in verbal mediation as opposed to the mere use or disuse of it. Other forms of mediation were also considered, but some of these may be too subtle and subjective to measure or control experimentally.

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LIST OF APPENDICES

APPENDIX I

WAIS Instructions and Code Key

The standardized procedure and instructions for the WAIS DSy Test are as follows (Wechsler, 1955, p. 44):

The examiner (E) places the WAIS record form containing the DSy Test before the subject (S), points to the code key and says:

> Look at these boxes. Notice that each has a number in the upper part and a mark in the lower part. Every number has a different mark. Now look here (pointing to samples) where the upper boxes have numbers but the squares beneath have no marks. You are to put in each of these squares the mark that should go there, like this (point to key then to samples). Here is a 2, so you would put in this mark. Here is a 1, so you put in this mark. Here is a 3, so you put in this mark.

The E writes in the first three symbols as demonstration, and then provides the S with a pencil and has him complete the seven remaining items of the sample. Pointing to the line that separates the samples from the test proper, the E says:

> Now you do it for these numbers as far as this line.

If the S does not grasp the task, he is helped with more items until the 10 sample items have been completed. The E then says:

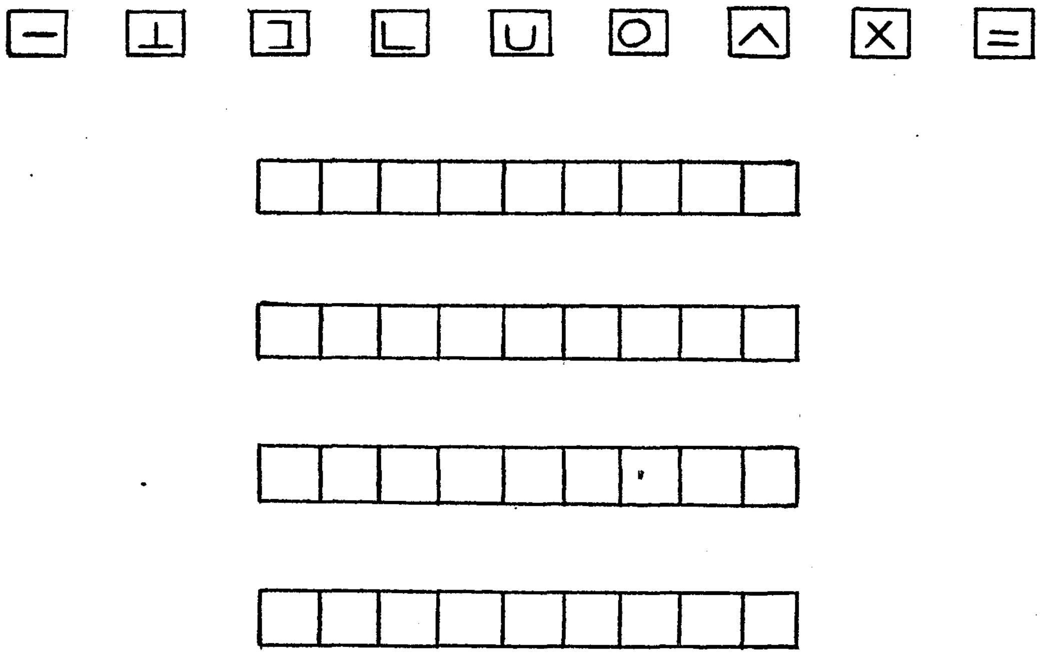
> Now, when I tell you to begin, start here and fill in as many squares as you can without skipping any. Ready, begin.

If a S starts to omit squares or to do only one type of figure the E says, "Do them in order and don't skip any." The time limit is 90 seconds and the score is one point for every square filled in correctly. Half credit is given for reversed symbols, and the 10 sample items are not counted in the scoring. Left-handed <u>S</u>s are given a second record form with the DSy code key showing, because some left-handed <u>S</u>s cover the key with their writing hand when filling in the symbols. The symbols and their associated digits as they appear in the code key are as follows:

1	2	3	4	5	6	7	8	9
−	⊥	⊐	L	U	O	Λ	X	=

APPENDIX II

Practice Sheet



APPENDIX III

Vocal Mediation Procedure and Instructions

The administrative procedure and instructions for the vocal mediation condition are as follows:

The _E_'s materials, as in the other conditions, consist of a practice sheet containing the symbols and four rows of empty squares (Appendix II), the DSy record form, and a well sharpened number two pencil. The initial instructions begin as the practice sheet containing the symbols is placed before the _S_. The _E_ begins:

> I have some marks here, and what I'd like you to do is to think of a short, descriptive label for each mark, and to say it out loud as you draw it. That is, I'd like you to say what each one is or what it looks like, and draw it at the same time. Draw the series of marks four times in these four rows of empty boxes and remember to say the names or labels for them at the same time. Do you understand? O.K. Ready, begin.

During this practice session, the _S_ learns to use an appropriate vocal mediation for each symbol. Whenever the _S_ departs from the instructions he is corrected until he clearly understands what is intended. If it happens that a _S_ cannot think of a label within 10 seconds (which should rarely occur), the _E_ will suggest a label from those listed in Table A. Previous research (Koestline & Dent, 1969; Personal Communication, Koestline, 1971) indicated that the labels indicated in Table A are those which most frequently occur to research Ss. If the suggested label does not appear meaningful to the S, he is helped to find an alternative label.

Table A

Suggested, Popular Labels

for the WAIS Symbols

WAIS Symbols	Suggested Labels
—	Dash
⊥	Upside Down T
⊐	Backward C
L	"L"
U	"U"
O	"O"
Λ	Upside Down V
X	"X"
=	Equals sign

When the S provides a label that is longer than three words (not including articles and prepostions), the E will say, "Good; now can you make the label shorter?" If the S is unable to shorten his label to a length of three words or less, the appropriate label from Table A is suggested. If a S persists in using an inappropriately long label, he is allowed to do so.

The remainder of the instructions are similar to the standard WAIS instructions described in Appendix I, but are adapted in order to remind the S to vocalize the labels as he performs the DSy Test. After the S completes the practice sheet, the E gives the following instructions as he places the DSy record form before the S:

> Fine. Now look at these boxes. Notice that each has a number in the upper part and a mark in the lower part. Every number has a different mark. Now look here (pointing to the samples) where the upper boxes have numbers but the squares beneath have no marks. You are to put in each of these squares the mark that should go there, like this (point to key then to samples). Here is a 2, so you would put in this mark. Here is a 1, so you put in this mark. Here is a 3, so you put in this mark.

The _E_ writes in the first three symbols as demonstration items, and provides the _S_ with a pencil and has him complete the seven remaining items of the sample. Pointing to the line that separates the samples from the test proper, the _E_ says:

> Now you do it for these numbers as far as this line, and remember to say the marks out loud at the same time.

These standardized sample items are used as a final check to see that the _S_ is using vocal mediation properly and understands the DSy task itself. Brief corrective comments are made by the _E_ when it is necessary. The instructions then continue as follows:

> Now when I tell you to begin, start here and fill in as many squares as you can without skipping any. Be sure to say each mark out loud as you use it. Do you understand? O.K. Ready, begin.

The _S_ completes the test as in the standard instructions. If the _S_ forgets to say the marks out loud, he is reminded to do so immediately.

APPENDIX IV

Competing Vocalization Procedure and Instructions

The administrative procedure and instructions for the competing vocalization condition are as follows:

The E's materials, as in the other conditions, consist of a practice sheet containing the symbols and four rows of empty squares (Appendix II), the DSy record form, and a well sharpened number two pencil. Before any of the materials are presented, the E begins with the following directions:

> The first thing that I'd like you to do is to practice saying the months of the year like this: January, February, March, April, May, June, July, August, September, October, November, December, January, February, and so on. Repeat this series of months over and over again without pausing after saying December. Do you understand? O.K. Begin.

In saying the months of the year for the S, the E demonstrates a rate of approximately one and a half months per second, but does not insist that the S say them at any particular speed, except that the S practices until he achieves a rate of at least one month per second and until he completes the series at least once. He must also demonstrate that he understands that he is to repeat the series without pausing after saying December. Most Ss require only one trial to achieve this. The purpose of insuring that the S can say the months of the year without difficulty and at a minimum rate of one month per second on the average is to avoid the possibility that any S's DSy performance might be slowed up by difficulty in saying the months of the year as such. During the rest of the test administration, no further emphasis is put on this, just so the S vocalizes at least one month for every symbol he draws. Otherwise, the S might well be able to subvocally mediate the symbols in between vocalization of the months.

After the S repeats the series of months adequately, which usually occurs on the first trial, the E presents the practice sheet (Appendix II) and gives the following instructions:

> I have some marks here, and what I'd like you to do is to draw them while you are saying the months of the year at the same time. That is, I'd like you to repeat the series of 12 months over and over again while you are drawing the marks. Now, draw the series of marks four times in these four rows of empty boxes, and be sure to continue saying the months of the year. Do you understand? O.K. Ready, begin.

During this practice session, the S learns to follow the competing vocalization instructions. Whenever the S departs from the instructions he is helped until he clearly understands what is intended.

The practice session is followed by the standardized WAIS instructions as the DSy record form is presented:

> Fine. Now look at these boxes. Notice that each has a number in the upper part and a mark in the lower part. Every number has a different mark. Now look here (pointing to the samples) where the upper boxes have numbers but the squares beneath have no marks. You are to put in each of these squares the mark that

> should go there, like this (point to key then to samples). Here is a 2, so you would put in this mark. Here is a 1, so you put in this mark. Here is a 3, so you put in this mark.

The E writes in the first three symbols as demonstration items, and provides the S with a pencil and has him complete the seven remaining items of the sample. Pointing to the line that separates the sample from the test proper, the E says:

> Now you do it for these numbers as far as this line, and remember to say the months of the year at the same time.

These standardized sample items are used as a final check to see that the S is using the competing vocalizations properly and understands the DSy task itself. Brief corrective comments are made by the E when it is necessary. The instructions then continue as follows:

> Now when I tell you to begin, start here and fill in as many squares as you can without skipping any. Be sure to say the months of the year over and over again as you fill in the marks. Do you understand? O.K. Ready, begin.

The S completes the test as in the standard instructions. If the S forgets to say the months of the year out-loud, he is reminded to do so immediately.

APPENDIX V

Spontaneous Mediation Procedure and Instructions

The administrative procedure and instructions for the spontaneous mediation condition are as follows:

The _E_'s materials, as in the other conditions, consist of a practice sheet containing the symbols and four rows of empty squares (Appendix II), the DSy record form, and a well sharpened number two pencil. The initial instructions begin as the practice sheet containing the symbols is placed before the _S_. The _E_ begins:

> I have some marks here, and what I'd like you to do is to draw them. Draw the series of marks four times in these four rows of empty boxes. Do you understand? O.K. Ready, begin.

After the _S_ copies the series of marks four times, the standard instructions (Wechsler, 1955) as described in Appendix I are introduced by the words, "Fine, now...." The standardized instructions are followed for the remainder of the administration, so that this condition is very much like that used in the ordinary administration of the DSy Test except for the practice sheet work which is included in order to make it more comparable to the vocal mediation and competing vocalization conditions. It is the same as the other two conditions except for the use of vocalized symbol labels in the one condition and the use of competing vocalizations in the other.

APPENDIX VI

MEDIATION USE SCALE

Name:______________________________ Age:______ Sex:______

During the task which you just finished, did you find yourself either mentally (silently) or vocally (out-loud) using a name or verbal label for any of the marks? (For example, when you looked at the mark "—" and drew it, you might have said "dash" (or some other descriptive label) mentally or silently to yourself, or even out-loud. I am interested only in whether you used labels like this as you worked on the task, not in whether you can do it now.)

1	2	3
YES	UNCERTAIN	NO

If you did say any of the marks either silently, mentally, or out-loud, please write down what you called each mark. If you used more than one such name or descriptive phrase for a single mark, list all of them.

Marks	Labels or Phrases Used to Describe the Marks
—	
⊥	
⊐	
L	
U	
O	
^	
X	
=	

APPENDIX VII

DIGIT SYMBOL QUESTIONNAIRE

Name:________________________ Sex:_________ Date:_________

Age:_____ Weight:___________ Height:___________

Highest Level of Education Completed (Circle one number.):

Elementary School	High School	College	Post-Graduate
1 2 3 4 5 6 7 8	1 2 3 4	1 2 3 4	1 2 3 4 5

Instructions:

In the following questions, please circle the rating which best describes your experience while performing the task that involved filling in the marks for each number. Some of the questions also call for additional comments or information.

1. How often did you look at the code key before writing the appropriate mark?

1	2	3	4	5
0-20% Of The Time	20-40% Of The Time	40-60% Of The Time	60-80% Of The Time	80-100% Of The Time

2. How often did you look to see what mark you filled in for a number the last time it appeared rather than checking back to the code key? (For example, having filled in the mark for the number 3 the first time it appeared in the test, the next time you come across number 3 you look at what mark you put down for it last time rather than checking the code key again.)

1	2	3	4	5
0-20% Of The Time	20-40% Of The Time	40-60% Of The Time	60-80% Of The Time	80-100% Of The Time

3. How much of the test time did you use in explicitly attempting to learn the number-mark associations?

1	2	3	4	5
0-20% Of The Time	20-40% Of The Time	40-60% Of The Time	60-80% Of The Time	80-100% Of The Time

4. How often did you check the code key even when you were pretty sure that you already knew which mark to use?

1	2	3	4	5
0-20% Of The Time	20-40% Of The Time	40-60% Of The Time	60-80% Of The Time	80-100% Of The Time

5. Compared to the maximum possible effort you could have made on the task, approximately what per cent of this effort did you actually expend? In other words, how hard did you try to do your best?

1	2	3	4	5
0-20% Not Hard At All	20-40% Tried A Little	40-60% Fairly Hard	60-80% Very Hard	80-100% Nearly As Hard As I Could

6. Before the experimenter suddenly directed you to stop working, were you aware that you should work as quickly as possible?

1	2	3
YES	UNCERTAIN	NO

7. Did you expect a time limit? That is, did you expect to be told to stop working, possibly before you were through?

1	2	3
YES	UNCERTAIN	NO

8. If you answered "no" or "uncertain" to the above question, would you possibly have done anything differently in your performance?

1	2	3
YES	UNCERTAIN	NO

What you might have done differently, if anything (Continue on the reverse side of the page if you need more space.):

____

____

____

____

9. Was there anything that the experimenter did which affected your performance?

1	2	3
YES	UNCERTAIN	NO

If there was, please explain as clearly and completely as possible specifically what he did and how it affected your performance (Continue on the reverse side if necessary.):

____

____

____

____

10. How much visual difficulty, if any, did you have in seeing the numbers and marks?

1	2	3
No Difficulty	A Little Difficulty	Much Difficulty

11. Are you involved in, or do you identify with, the "women's liberation movement?"

1	2	3
YES	UNCERTAIN	NO

12. Do you think that you have a "photographic memory?"

1	2	3
YES	UNCERTAIN	NO

13. Approximately how many hours of leisure time each month do you spend in knitting, sewing, crocheting, embroidering, weaving, or similar activities?

Approximate Hours Per Month:____________

14. If you are not currently a student, please skip this item. What was your cumulative grade point average as of your last report card (estimated to the nearest tenth)?

Cumulative Grade Point Average:____________

15. In the squares beneath the numbers fill in as many of the corresponding marks as you can remember:

1	2	3	4	5	6	7	8	9

16. Often, the participating volunteer, really a partner of the experimenter in the research endeavor, has something additional to contribute—an opinion or an observation perhaps, which he is often not able to contribute because he simply isn't asked the right question. Therefore, please make any additional comments that you feel may be relevant and helpful. (Continue on the reverse side if you need more space.) Additional Comments:

17. Did you like the experiment?

1	2	3
YES	UNCERTAIN	NO

18. Thank you very much for participating in my experiment. Without your cooperation, I would not be able to conduct this research, and consequently, I would not be able to graduate. Although I will not be able to explain much about the experiment to you at the present time, as soon as all volunteers have participated and the data is analyzed, I will enjoy explaining everything and discussing the results with you.

IMPORTANT: PLEASE DO NOT DISCUSS THIS EXPERIMENT WITH OTHERS WHO HAVE NOT YET PARTICIPATED IN IT. THE VALIDITY OF THE RESULTS MIGHT BE AFFECTED IF THIS WERE DONE. THANK YOU.

APPENDIX VIII

DSy Scoring Guide

Wechsler's (1955) directions for scoring the DSy Test indicate that the score is the number of squares correctly filled in within the time limit, with only half credit given for reversals. Unfortunately, no indication is given as to what constitutes a correct response. If for the symbol $\cup$ a S writes "u" (alphabetical letter u), is this correct? If a S draws a wrong symbol, but then draws the correct one over it without erasing, is he given full credit? After a correct response for the $\wedge$ symbol, if the S adds a horizontal line, making it look like the capital letter A, how is this scored? Are 90 and 180 degree rotations to be considered as reversals and consequently given half credit? How badly scribbled or distorted does a symbol have to be before it is given zero credit? These are scoring ambiguities which different Es are likely to resolve in different ways. Each will have his own opinion or interpretation of Wechsler's instructions, but there is no objectively "correct" way of scoring these ambiguous items because they were not discussed in the test manual. The "correct" way of scoring these ambiguous items would be whatever way a majority of psychologists use, especially those psychologists who have published studies involving the DSy Test.

Consequently, a "Symbol Scoring Study" was prepared in order to find some consensus among psychologists as to the scoring of the five classes of scoring ambiguities described above (Appendix IX). These ambiguities were labeled as follows: alphabetical elaborations, unerased extra lines, contaminations, rotations, and motor distortions, respectively. In the "Symbol Scoring Study" questionnaire, examples of each scoring ambiguity were listed, with the respondent being asked to score each example by assigning values of one, one half, or zero to each one. The respondent was also asked to give a clarifying comment concerning the criteria which he used for each type of scoring ambiguity. This questionnaire, which is presented in Appendix IX, was mailed to psychologists who had published data concerning DSy errors or who had published studies concerning DSy data of basic significance. The total $\underline{n}$ was only seven for this exploratory investigation of DSy scoring criteria, but the respondents were especially qualified. Only four of these authors filled out and returned the questionnaire.

All four assigned full credit to the "u" example of alphabetical elaborations. Three out of four also gave full credit to the other examples of alphabetical elaborations, for both printing and cursive variations. Concerning unerased extra lines, three out of four gave some credit for every example. For contaminations, only one respondent gave full credit;

two gave clear cut zero credit; and one gave half credit if the *S* consistently used the same contamination each time the symbol appeared. Three out of four respondents scored rotations as zero credit responses, and therefore, not the same as reversals (left-right). As for motor distortions, the respondents tended to give the *S* the benefit of the doubt. Three out of four assigned full credit to most of the motor distortions except for those which could just as easily be interpreted as one of the other symbols. A general rule, formulated by one of the respondents was, in effect, that the *S* should be given full credit for an item if it can be determined that he intended the correct symbol. Such determination can be facilitated by an inspection of the total pattern of responses.

This general rule was adopted for the present study because it appears to be uncomplicated, easily applicable, and most consistent with the consensus of the respondents on each item of the Symbol Scoring Study. Furthermore, it is consistent with the traditional interpretation of DSy as emphasizing quantitative rather than qualitative aspects of performance. Specifically, the scoring criteria used in the present study were as follows:

Generally, a response was given full credit if, by studying the total pattern of responses, it could be determined that the *S* intended the correct symbol. Alphabetical elaborations such as adding a little "tail" to the U symbol as in printing the letter u were considered merely to be stylistic variations and, as clearly recognizable reproductions of the appropriate symbol, were given full credit. Unerased extra lines did not disqualify the response from full credit unless there was ambiguity as to which of the two marks was the intended response and which was the rejected one. Contaminations, which were rare, were scored zero when the mark could be interpreted as an "intrusion" of another symbol rather than a distortion or elaboration of the correct symbol. Reversals were assigned half credit, but rotations were not considered reversals (left-right), and hence were scored zero. Motor distortions or imperfections of reproduction, often due to tremor, poor motor control, or a "slap-dash" performance were assigned full credit unless they were indistinguishable from another symbol. In all of these scoring categories, the consensus of the respondents on the Symbol Scoring Study questionnaire was accepted.

APPENDIX IX

SYMBOL SCORING STUDY

Directions:

Wechsler's (Wechsler, 1955) directions for scoring the Digit Symbol Test indicate simply that the score is the number of squares correctly filled in within the time limit, with only half credit given for reversals. In order to help further specify what is included as a correct Digit Symbol response, you are being asked to fill out this form.

Please indicate your method of scoring each of the following examples by filling in the point credit (1, $\frac{1}{2}$, or 0) that you would assign to each, and give clarifying comments concerning the criteria you used.

1. Alphabetical Elaborations.

Examples:	Point Credit
A) Printing Type	
a) U for U	____
b) L for L	____
c) V for U	____
B) Cursive Writing Type	
a) O (OR L, U, X, etc.)	____
b) o (OR l, u, x, etc.)	____

Comments: ____

____

____

2. Unerased, Extra Lines.

Examples: **Point Credit**

a)  for ⊐ ______

b)  for Λ ______

c)  for = ______

Comments: ____

____

____

3. Contaminations.

Examples: **Point Credit**

A for Λ ______

Note: This is distinguished from "Unerased, Extra Lines" in that the contaminating line is not rejected by the S as an error, and is usually added after the symbol is drawn.

Comments: ____

____

____

4. Rotations.

Examples: **Point Credit**

a) V for Λ ______

b) U for ⊐ ______

c) ∩ for U ______

Note: The question involved here is whether rotations are to be scored as reversals ($\frac{1}{2}$ credit) or as incorrect symbols (0 credit).

Comments: ______________________________

____

____

5. Motor Distortions.

Examples: **Point Credit**

a)  for ⊥ ______

b)  for ⊃ ______

c)  for L ______

d)  for O ______

e)  for U ______

f)  for U ______

g)  for Λ ______

h)  for ⊥ ______

i)  for ⊃ ______

j)  for ⊃ ______

Comments: ______________________________

____

____

General Comments:

____

____

____

____

____

Thank you very much for your cooperation. I would like to cite you in my dissertation, and possibly quote you if any of your comments would help to clarify your approach to scoring better than I could paraphrase you. I may also attempt to publish a book on the Digit Symbol Test, and may include a section on scoring problems, but this is highly tentative. Please check one of the following, if possible:

_____ Yes. You may quote me and/or cite me in both your dissertation and your book.

_____ You may quote and/or cite me in your dissertation, but not in your book.

_____ You may cite me in your book and dissertation, but no quotes, please.

_____ You may cite me in your dissertation only.

_____ You may use my responses, but only anonymously as "an author who has published research on the Digit Symbol Test" or some similar designation.

Signature: ______________________________

APPROVAL SHEET

The dissertation submitted by Jerome S. Pietrzak has been read and approved by members of the Department of Psychology.

The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

January 17, 1973
Date

Ronald E. Walker
Signature of Advisor