REWARD EFFECTS AND RESPONSE LATENCY IN THE PROCESS OF INTERNALIZATION

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REWARD EFFECTS AND RESPONSE LATENCY IN

THE PROCESS OF INTERNALIZATION

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All integrative processes are directive. At every step from lower to higher levels something new is added. The higher patterns are not made by simple additive assembly of the properties of the lower, and the laws of their operation are not identical with those of the lower. This is as true of chemical reaction as of the creative imagination of a philosopher or a poet.

C. Judson Herrick, The Evolution
of Human Nature (1956)

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Ultimately I would thank my parents who guided and encouraged my development.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The main body of this dissertation consists of a complete manuscript, Reward Effects and Response Latency in the Process of Internalization, based on the doctoral thesis research of Sylvia T. Buse.

Materials, which, according to Oklahoma State University thesis format, are generally included in the main text of the dissertation (e.g., the literature review) are included in the appendices. The appendices also include the raw data, varied statistical analyses, and supplemental materials such as letters to the subjects, and forms for recording subject data.

A preliminary report based on the results of Experiment 1 was presented at the American Psychological Association, Los Angeles, California, 1981; and a subsequent report, based on aspects of both Experiment 1 and 2, was presented at the Southwestern Society for Research in Human Development, Galveston, Texas, 1982.

Reward Effects and Response Latency in the Process of Internalization

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This article is based on the Ph.D. dissertation research of the first author under the direction of the second. Preliminary reports were presented at the annual meeting of the American Psychological Association, Los Angeles, California, 1981, and at the biennial meeting of the Southwestern Society for Human Development, Galveston, Texas, 1982. Financial support for the research was provided to the second author by the College of Home Economics, Oklahoma State University, and to the first author by an educational leave from Southwest Missouri State University. The authors would like to thank the students and teachers of the Psychology Department and the Department of Family Relations and Child Development, Oklahoma State University; Limestone School and St. John's School, Bartlesville, Oklahoma; St. Agnes School, Springfield, Missouri; and the Senior Citizen Center, Stillwater, Oklahoma, for cooperation in making subjects available. Reprint requests should be sent to the first author, Department of Psychology, Southwest Missouri State University, Springfield, Missouri, 65804.

Running head: Reward and Latency in Internalization

Abstract

Two experiments are reported that attempted to replicate and extend Leont'ev's (1932) research on the role of external sign utilization in the development of the internal control of behavior. The aim of Experiment 1 was to disentangle the effects of rewards from those of external aids. Subjects at six age levels (4 to 85 years) responded to three series of questions: Series I, practice condition--no constraints; Series II, specified colors forbidden in replies; Series III, like Series II, but with external aids (Color Cards). Results supported Leont'ev's developmental trends, indicating that 8- and 9-year olds were helped by memory aids; younger children and the elderly (70-85 years) were hindered by the aids; and older children (10-12 years) and young adults did not need them. Reward was found to be associated with increased response latencies. Since increased latencies and improved performance were obtained with both rewards and aids, the next question was: Does the child's control of behavior depend on using external signs and internalizing them or on the ability to inhibit initial responses? The subjects of Experiment 2 were third-grade children whose responses were artificially delayed for either zero or 3 seconds, with and without aids. The results of the second study revealed that subjects speeded up their responses and made more errors in spite of external aids. The results of both studies were examined in the context of White's (1965) concept of temporal stacking. While rewards may serve to increase response latencies in this task and

thereby improve performance, merely slowing subjects' responses through an externally imposed temporal delay does not produce the reward effects observed in the first study.

Reward Effects and Response Latency in the Process of Internalization

A question that has long intrigued Russian investigators is how children come to organize and control their behavior. Ivan Pavlov laid the foundation for the study of this phenomenon, which is essentially a question of how involuntary behavior is transformed into voluntary behavior. His work suggested that voluntary behavior is a result of verbal planning that precedes overt action (Pavlov, 1928/1941) while involuntary behavior can be considered as non-directive and unintentional. Other Soviet researchers extended Pavlov's early studies and suggested that the transformation of biological reflexes into voluntary behavior is related to the development of attention (Leont'ev, 1932; Vygotsky, 1929/1979; Yendovitskaya, 1971).[1]

Lev Vygotsky, a Russian psychologist of the 1920's, pointed out (e.g., Vygotsky, 1929/1979) the importance of biological, genetic, and cultural factors in the development of attention. He proposed that the development of voluntary behavior becomes possible only through the individual's ability to master and control stimuli. According to Vygotsky voluntary behavior emerges as a result of the use of various external stimuli by adults to guide and control the child's attention. In this way, adults give children a means by which they subsequently can control their own behavior. Thus, the stimuli originally meted out by parents become "internalized" by the child. The process whereby external stimuli are reconstructed to internal thought processes has been called "internalization" by Vygotsky (1930/1978). Galperin

(1967) described internalization as the process of forming inner mental processes--the "inner plane"--through utilization of stimuli from the external physcial environment.

In the late 1920's, A. N. Leont'ev, one of Vygotsky's students and collaborators, explored a segment of this internalization process by researching the role of external signs in memory as these related to the process of transforming external signs into internal ones. He reasoned that providing children with an external aid in a task should facilitate their control of behavior. Consequently, he set up a situation where he could observe how subjects of various ages utilized external aids to organize their answers and subsequently reduce errors.

In Leont'ev's original study (1932) the child was placed in a situation which required active concentration of attention and memory; the child was then offered a number of colored cards (external objects) which might serve as the "psychological means" to help the child in this activity. However, there also was another set of external stimuli in the study that Leont'ev did not consider in his interpretation of the results: "prizes for winning." Thus, the methodology of Leont'ev's study involved both material rewards and external aids such that it is not clear whether his results were due to the aids or the rewards or both.

The present set of studies was designed both to correct this methodological problem (i.e., confounding rewards with aids) and to explore further the issue of how external cues become internalized. The need to resolve this question stems from more than historical curiosity. The question of how external stimuli relates to the construction of an internal representation of the world continues to be of

interest and concern to present-day investigators, both in and out of the Soviet Union. For example, neurophysiological research is intent upon exploring the relationship of external and internal events to attention (Pribram & McGuinness, 1980). A recent article by Kopp (1982) has indicated that the transition from external to internal control is influenced by both maturation and experiential processes, although the mechanisms underlying these processes remain to be explored. Several modern Soviet researchers have launched investigations into the nature of the internalization process. Galperin (1969) and El'konin (1972) have stressed the formation of internalized intellectual operations by stages. Other aspects of the internalization process in terms of the development of complex voluntary actions in the preschool child have been studied by Zaporozhets (1955/1957).

The purpose of the present study was to reexamine the use of external aids more closely with three main questions in mind. First, what is the effectiveness of external aids in remembering rules and colors? Second, what is the specific role of rewards in the internalization process? That is, does reward enhance or interfere with the process? This question is important, particularly in view of the fact that extrinsic incentives have been found in recent years to produce adverse effects on human behavior and motivation (see, e.g., Lepper & Greene, 1978). Third, do rewards have the same effect at all age levels? For example, several recent studies investigating the capacity of extrinsic rewards to undermine intrinsic interest have reported that rewards had a positive effect, rather than a detrimental effect, upon the interest and performance of young children (Loveland & Olley, 1979; McLoyd, 1979; Sarafino & Stinger, 1981).

Experiment 1

Experiment 1 was designed, specifically, to disentangle the effects of rewards from those of memory aids and examine the effects of both on verbal behavior from a developmental perspective. Leont'ev's (1932) study was replicated with additional controls for reward effects. The age range was extended in both directions to include a preschool group and an elderly group in an effort to determine reward and aid effects more adequately and further identify developmental trends.

Leont'ev's study. In Leont'ev's investigation, 30 subjects at four age levels, ranging from 5 to 27 years, were placed in a game-like situation, which consisted of either three or four series of eighteen questions each, seven questions concerning color (e.g., "What color is lettuce?"). All four series were similar in difficulty and each contained an equal number of color questions distributed in the same manner within the series. The first series constituted a "training" series and had no verbal constraints; the second series had two verbal constraints (i.e., the child was forbidden to use two colors and no color could be repeated); the third series was the same as the second, but nine color cards were provided to assist the child in remembering the rules and the colors that had been used. The fourth series of questions was similar to the third but essentially was a teaching condition, designed for those who could not determine how to use the cards. The child was given the opportunity to "win" a certain prize if he/she did not name one of the "forbidden" colors or repeat a color name. At the end of each series of questions, the child was questioned to check his/her memory for the instructions. Table 1 presents the

questions used in Leont'ev's original research and those of the pres-

Insert Table 1 about here

ent study.

Method

Subjects. The subjects were 144 predominately white, middle- to upper middle-class individuals residing in Stillwater and Bartlesville, Oklahoma, both small cities with a high proportion of well-educated middle-class, professional people. There were 24 subjects at each of six age levels; preschool (mean age = 4 years, 8 months), first grade (mean age = 6 years, 9 months), third grade (mean age = 8 years, 8 months), sixth grade (mean age = 11 years, 9 months), college (mean age = 25 years, 8 months), senior citizens (mean age approximately 77 years, 9 months; an exact mean age was not available since several of the elderly adults preferred not to give their age). Senior citizens averaged 10.46 years of education with a range of 4th grade to one year of graduate school. At each level, the subjects were assigned to either a reward or nonreward group, with 12 subjects per group. The preschoolers were drawn from the university nursery school; the elementary school children attended public and parochial grammar schools; college students were undergraduate and graduate psychology students who volunteered to participate; and the senior citizens attended a community Senior Citizens Center. The preschool and elementary school children who received rewards came from different schools than the nonreward subjects to minimize communication regarding rewards. Compara-

bility of the two school systems was estimated by composite percentile scores obtained from SRA achievement series given at the third grade level. A t-test performed on these data yielded a nonsignificant difference, $t(19) = 1.76$, between the public and parochial schools. One Down's Syndrome child and one other child who did not have a functional verbal knowledge of colors were dropped from the data analysis of the preschool group.

Materials and design. As in Leont'ev's study, the task consisted of three series of eighteen questions;[2] nine color cards (red, blue, white, black, green, purple, brown, yellow, and gray) served as the external memory aids for the third series of questions. These were the same colors used by Leont'ev. The study followed a 6 (Ages) x 2 (Reward vs. Nonreward) x 2 (Aids vs. No Aids) mixed factorial design in which Age, and Reward-Nonreward were between-subjects factors and Aids versus No Aids was a within-subjects factor.

The questionnaires. The questions used in this study were essentially the same as those in Leont'ev's study with slight modifications to make them appropriate to the 1980's and to make it possible to use the questions with preschool children. In each series, there were eleven general information questions that could be easily and quickly answered by the subject and seven questions concerning the color of an object. As in Leont'ev's study, only the color questions were scored.

Procedure. The subjects were asked to play a kind of game in which they were to answer a set of questions without using certain words ("forbidden" colors). All subjects were presented three series of questions: (a) a baseline practice condition (Series I), a verbal constraint condition (Series II), and (c) an aid condition (Series

III). Series II and III were presented under either reward or nonreward conditions. The three series of questions were presented in a constant order, rather than counterbalanced across conditions; this was done partly because Leont'ev had tested the questions used in each series and found them to be of equal difficulty, and partly to keep the present replication effort procedurally comparable to the original study. The subjects participated individually at their respective schools or Senior Citizens Center.

In Series I, the questions had no verbal constraints, and no aids or rewards were used. The purpose of these questions was to establish rapport between subject and experimenter, to allow the subjects to gain practice with the type of questions to be used in the actual task conditions, and to make certain each individual understood what was expected. These questions also provided a basis for comparing the initial performance of reward and nonreward groups under nonreward conditions. The subjects were instructed to answer each question quickly and with one word.

In Series II, the questions had two constraints: the subjects were instructed as before, but asked not to name specific colors in their replies (e.g., "Don't say <u>blue</u> and <u>red</u>") and also not to name the same color twice (e.g., "Don't repeat a color").

In Series III, the questions had the same constraints as Series II, but the subject was given the nine color cards to use as aids in remembering the two "forbidden" colors and in remembering which colors had been used so as not to repeat a color. The instructions to the nonreward subjects were: "Take the cards, they will help you." Instructions to the reward subjects were: "Take the cards, they will

help you to win." No further instructions were given as to the use of the aid cards.

Subjects in the reward group were offered a monetary reward or "prize" for Series II and another for Series III, provided that all questions in a series were answered correctly. The reward consisted of ten cents for the preschoolers and first graders, twenty-five cents for the third and sixth graders, and one dollar for the college students and senior citizens. These variations in the amount of money given as a reward were made in an effort to make the reward somewhat psychologically comparable across ages.

Instructions were repeated or paraphrased as necessary to ensure that the subjects understood them. After each series, the subjects were questioned to determine if they remembered and understood the directions: "Do you think you have them all correct?" "What were the rules of the game?" "And, what else?" "Did the cards help you?" "In what way?"

The elapsed time between the presentation of the question and the subject's response was recorded in seconds by a stopwatch for the seven color questions in order to assess the relationship between response latency and performance. Vygotsky (1930/1978) believed that changes in memory and attention could be discerned in terms of the measurement of reaction time. For example, a longer reaction time in experiments where children utilize external aids indicated that the child was using the external means to accomplish the remembering.

Results

Analysis of Error Data[3]

Mean error scores for the thirty subjects in Leont'ev's study, all under reward conditions, and the present subjects are presented in Table 2. Means and standard deviations are presented separately for each

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Insert Table 2 about here

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treatment (Reward vs. Nonreward) and memory aid (Aid vs. No Aid) condition in Table 2 for the present subjects.

An examination of Table 2 reveals that the developmental trends were quite similar in Leont'ev's and the present study, for the age groups represented in both studies. The present study showed a lower error rate than the original. The Leont'ev study revealed greater differences between the aid versus no aid conditions than were found in the present study.

The error scores were analyzed by a 6 (Ages) x 2 (Treatments: Reward vs. Nonreward) x 2 (Memory Aid Conditions: Aids vs. No Aids) factorial analysis of variance with the last factor being a within-subjects factor. A significant effect of Age, $F(5, 132) = 38.52$, $p < .001$, was revealed. Duncan's comparisons indicated that the preschoolers and first graders and the elderly subjects made significantly more errors than the sixth graders and college students. The level of significance was set at $p < .05$ for all Duncan comparisons.

There was no significant main effect due to the presence or absence of aid cards; however, the interaction of Memory Aids with Age,

$F(5, 132) = 2.72$, $p < .02$, was significant. Duncan's multiple comparisons indicated that memory aids had a significant negative effect on the performance of preschoolers, first graders, and the elderly, a significant facilitation at the third and sixth grade levels, and no effect at the college level.

Rewarded subjects performed better overall than nonrewarded subjects, but this difference fell short of significance, $F(1, 132) = 2.87$, $p < .09$. With the adult groups (college and elderly) removed, a significant reward facilitation effect was revealed for the four child groups, $F(1, 88) = 7.55$, $p < .007$.

Role of Response Latency

The latency data were analyzed via a three-factor analysis of variance with repeated measures on one measure, where, again, Reward and Age were between-subjects factors and Memory Aid Condition was a within-subjects factor. Separate analyses were performed using correct response latencies and error latencies as scores. Correct response latencies were based on the questions correctly answered out of a possible total of seven questions for each subject. Similarly, the error latencies were based on the time to first response for each question answered in error.

Correct response latencies. Numbers of correct responses and correct response latencies in seconds are shown in Figure 1. Both revealed a systematic increase through the sixth grade. The analysis of

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Insert Figure 1 about here

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variance of correct response latencies revealed an overall Memory Aid effect, $F(1, 132) = 16.18$, $p < .001$, due to the fact that subjects responded more slowly with aids than without. This analysis also indicated that Age was significant, $F(5, 132) = 4.51$, $p < .01$. Duncan's comparisons showed that the third and sixth graders responded more slowly than the preschool and first grade children. It is interesting to note that the first graders and the elderly did not differ from each other in correct response latencies.

As found in the analysis of errors, Reward proved to be nonsignificant, $F(1, 132) = 2.76$, $p < .09$, with all ages included in the analysis. With the older groups removed (college and elderly), a significant effect of Reward emerged, $F(1, 87) = 4.92$, $p < .02$; that is, rewards as well as aids, slowed the four child groups' responses.

Error latencies. Numbers of errors and error latencies are presented in Figure 2. Error latencies (Figure 2) were consistently shorter than correct response latencies (Figure 1). An analysis of

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Insert Figure 2 about here

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variance on error latency data was not feasible because the numbers of subjects that made errors decreased as age increased such that only one subject in the college group made errors. However, with the older groups removed, a marginally significant effect for Aids was revealed, $F(1, 52) = 3.39$, $p < .07$, due to latencies being longer with aids.

Sex Effects

The sex factor was not analyzed in Leont'ev's original study and

for that reason the present data cannot be compared to Leont'ev's. Thus, sex was not a variable of interest in the present study. However, when separate analyses were performed with sex included as a factor, there were no significant sex effects in the analysis of error scores, and only one significant effect was found in the latency analysis: the triple interaction of Sex, Age, and Treatment (Reward vs. Nonreward), $F(5, 120) = 2.66$, $p < .02$. Specific comparisons indicated that elderly males and sixth grade girls in the nonreward group were significantly slower in their correct responses than rewarded male college and elderly females. Further, since the ratio of males to females was quite unbalanced in some of the present age groups, even the single sex effect reported here should be accepted with caution.

Supplemental Analyses

In order to examine the relationship of errors to speed of responding, correlations were computed between numbers or errors and latency scores for each subject under No-Aid and Aid conditions. Significant correlations were obtained between errors and correct response latencies under both No Aid, $r(142) = -.51$, $p < .01$, and Aid, $r(142) = -.46$, $p < .01$, conditions; and between error and error latencies under No Aid, $r(142) = .38$, $p < .01$, and Aid, $r(142) = .37$, $p < .01$, conditions. These relationships, observed in the combined data were also found in separate analyses at each age level, with one exception: at the college level under the aids condition, there was a nonsignificant positive correlation between errors and correct response laten-

cies.[4] Thus, longer correct response latencies were associated with fewer errors, which suggested that accuracy increased when subjects took more time to respond. However, increased errors were associated with longer error latencies; this relationship may have been an artifact of the small numbers of errors across all ages.

Qualitative Data

It appeared that the use of aid cards during the task could be categorized into four essential patterns. The first of these was an inconsistent use of aid cards. This pattern essentially characterized the preschoolers and first graders. Occasionally the young child would begin by putting aside the blue and red cards, but would forget that she/he had done so. At other times, a child might use the cards merely to select a color (e.g., "I think I'll say red"), but the color chosen did not necessarily conform to the rules. The second pattern involved consistent use of cards with method evident. The third and sixth graders would usually spread out all the cards in front of them and first put aside the cards for the forbidden colors, and then put aside other cards as they used them in the "game." A third pattern occurred where the use of cards was not always evident. Young adults looked at the cards, but did not always arrange or manipulate them overtly, as was observed with the third and sixth graders. The fourth pattern was one of card rejection. With the elderly group, the majority indicated that they did not wish to use the cards (e.g., "I can remember the colors"). However, a few subjects in this group did not discover how to use the cards effectively until the end of the series of questions.

Discussion

In comparing the present study with Leont'ev's research, developmental trends remained the same across age, with the exception of the elderly group which was not represented in Leont'ev's study. The present study showed a lower error rate than the original.

On the general process of internalization, what emerged was essentially four different patterns, the first three of which were entirely consistent with Leont'ev's (1932) three stages: (1) where they cannot utilize the signs effectively; (2) where the external signs usage reaches a maximum; (3) where they respond to internally-produced stimuli and do not require signs. The present elderly data suggest that a fourth stage may occur among the aged in which they attempt to respond as though they were in Stage 3, but can no longer do so effectively.

Overall, in the present study, there was a tendency for the subjects to make more correct responses than errors and a tendency for the latencies to increase with age. For the young adults, latencies dropped sharply and performance was nearly perfect, suggesting that the task was very easy for them. Prior to adulthood, there appears to be a trade-off between accuracy and speed, suggesting a potential connection between the present research and work on reflective and impulsive response styles (e.g., Kagan, 1966). Errors tended to come from making responses relatively fast. This is understandable considering that the task required the subject to inhibit responses. Those subjects who were unable to inhibit first responses would be more likely to make errors. Longer response times would allow an opportunity to

inhibit first-but-incorrect responses.

The overall effect of reward was to increase latencies and reduce errors with or without the aid cards. This raised a question as to the development of verbal control and the role of aid cards in that process. That is, does the development of voluntary control depend on internalizing external signs as Vygotsky suggested, or on the ability of the child to inhibit early choices? This latter possibility would seem to be consistent in some ways with White's (1965) conception of competing responses arranged in zones along a time line. Impulsive behavior leads to first-available responses, while restraint is necessary to the production of second-available responses.

If, in fact, rewards really have the effect of slowing down responses, then reward effects might be produced by devices that merely affect response latencies. Could a study be arranged to slow down the subject artificially? If so, could we replicate reward effects observed in the present study? Experiment 2 was designed to investigate these questions.

Experiment 2

In order to explore the role of temporal factors, Experiment 2 was conducted as a replication of Experiment 1, at one age level (third graders). Data from Experiment 1 indicated the third grade (8 to 9 years) to be a critical time in terms of assimilating external aids. Vygotsky also viewed the eight-year old age as being critical for study, particularly as related to the internalization of spontaneous self-regulatory speech (see, e.g., Zivin, 1979). The procedure for Experiment 2 made use of two temporal delay intervals--immediate re-

sponse (zero-second delay) and response after a three-second delay. These two delay periods, zero and three seconds, were selected because the overall average difference between reward and nonreward groups in Experiment 1 was approximately three seconds. Thus, the central question of Experiment 2 was whether a three-second delay imposed externally would produce results similar to those found under reward. Reward was not manipulated in the second study.

Method

The instructions, materials, and procedures were the same as in Experiment 1, except for the modifications noted below.

Materials

Each of the three questionnaires was increased to twenty-four questions (ten questions in each set concerned with color), and twelve color cards (the nine colors used in Experiment 1 plus orange, pink, and tan) were used with Series III. The length of the questionnaires and the number of color questions were increased to reduce the possibility of ceiling effects, since the results of Experiment 1 revealed a very high proportion of correct responses.

Apparatus and Procedure

The apparatus consisted of two Hunter Timers (model 1275) and a Lionel miniature railroad semaphore powered by a standard six-volt battery used to signal each subject to respond to the question. At the end of the specific delay interval, the signal arm moved up and the light changed from red to green.

In the zero-second condition, the child's response would commence as soon as the question was asked. In the three-second condition, a three-second delay was required before the subject could respond to the question. In both cases, the subject was instructed: "When the signal goes up and the light turns green answer quickly with one word." The experimental session began with practice trials to acquaint the children with the railroad signal and continued until each child knew what to do. The number of practice trials varied from one to three per child.

Subjects and Design

A total of 63 children, ranging in age from 8 years, 6 months to 9 years, 11 months with a mean of 9 years (18 boys and 16 girls) were drawn from third grade parochial elementary schools in Springfield, Missouri, and Bartlesville, Oklahoma. All subjects came from homes in predominately white, middle-class communities, with parents generally of above-average educational levels. A comparison of SRA achievement test scores for the third grade subjects yielded no significant difference between the two parochial schools.[5] The children were randomly assigned to the two experimental conditions. The design represented a 2 x 2 x 2 mixed factorial model. Delay interval (zero-second vs. three-second delay)[6] and Sex were between-subjects variables and Memory Aid (aids vs. no aids) was a within-subjects variable.

Results

The mean numbers of errors and correct responses, and the means for correct response and error latencies and their standard deviations

are presented in Table 3 separately for the Aid and No Aid conditions. Table 3 also shows for comparison purposes the data for the third

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Insert Table 3 about here

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grade children in Experiment 1.[7] From Table 3 it can be seen that the procedure of Experiment 2 had the effect of speeding up the subject's responses and reducing the number of correct responses relative to Experiment 1.

Again, separate analyses of variance were performed on correct response latencies, error latencies, and numbers of errors. The analysis of error data indicated that the zero- and three-second delay groups did not differ significantly in numbers of errors. The main effect for Memory Aids was significant, $F(1, 30) = 5.90$, $p < .02$, indicating that the use of aids produced fewer errors. Not surprisingly, the three-second delay group responded more slowly than the zero-second delay group, but not significantly so. The only significant effect in the analysis of correct response latencies was the interaction between Delay Interval and Sex, $F(1, 30) = 8.26$, $p < .007$, which resulted from the tendency of girls in the zero-second group to respond more slowly than boys. No significant effects were found in the analysis of error latencies.

Supplemental Analysis

To investigate the possibilities of a relationship between speed of response and accuracy of response, correlations were computed between number of errors and latency scores of each subject. Significant

correlations were obtained between errors and correct response latencies, $r(24) = -0.37$, $p < .05$; and errors and error latency, $r(34) = -0.48$, $p < .05$. Thus, at this age level making errors seems to be related to responding too quickly. A comparison of the correlations between number of errors and correct response time for the third graders in Experiment 1 with the third graders in Experiment 2 indicated that the proportion of correct responses definitely decreased for Experiment 2 children.

General Discussion

The results of the present experiments provide some answers to the questions initially posed. The developmental trends in the present data generally paralleled those originally reported by Leont'ev, namely that the efficient use of aids/external stimuli increased with age. However, in contrast to Leont'ev's study, the subjects in the present studies did not demonstrate as great a difference between the aid and no aid conditions. There is no obvious reason for this difference. Leont'ev's and the present research were conducted half a century apart in time and, as Wozniak (1972) has pointed out, there are many differences in research technique and style of conducting experiments in the two cultures (Russia and the United States) that could account for discrepant findings.

The present data contain some interesting implications concerning behavioral controls. For example, how shall we interpret the similarities in performance between the first grade and the elderly subjects? The perhaps prevailing viewpoint is that observed similarities between young children and the elderly are superficial ones, and the underlying

mechanisms at the two ages are different (Klahr, 1981; Werner, 1961). An alternative viewpoint emerging from the present data is that the performance of the elderly and young children is similar precisely because the "deep" or underlying mechanisms are the same. That is, in both cases, higher levels of cortical functioning may be absent for two different reasons. In the younger children, the higher mechanisms have not yet developed, while in the elderly they may be in the process of decline. This suggests, in the case of the elderly, that once later maturing, higher cognitive functions begin to erode, the individual is forced to utilize those more enduring and ontogenetically prior capacities that remain.

Of possible relevance in this context are the findings of Hasher and Zacks (1979), who indicated that cognitive processes lie along a continuum from "automatic" to "effortful" in terms of the attentional capacity required for the task. Automatic processes do not require effort, occur spontaneously and unintentionally (Posner & Snyder, 1975); further, automatic processes are characterized as difficult to suppress when aroused, do not result of their own volition in storage of new information, may develop (under special conditions) with repeated practice (Shiffrin & Schneider, 1977); they show little developmental change and are perhaps genetically determined (Hasher & Zacks, 1979). In contrast, effortful processes (e.g., imagery, rehearsal, organization, and memory strategies) are voluntary, decline with age, benefit from practice, show developmental change, require considerable attentional capacity, and show a wide range of individual differences (Hasher & Zacks, 1979). The Hasher and Zacks (1979) finding indicated that both the young and elderly had difficulty with processes involving

imagery and memory strategies but for different reasons--young children because they have not yet developed the skills (e.g., effortful, processes) and the elderly because the processes are in decline. Thus, Hasher and Zacks seem to offer developmental evidence which supports the present study findings of a similarity of performance in the young and elderly.

A primary goal of this research was to disentangle the role of rewards and aids and examine their effects on verbal behavior. In Experiment 2 it was hypothesized that imposing an external delay would slow the subjects' speed of response and possibly decrease errors; if so, then delay effects would resemble reward effects. However, the result of the artificially imposed delay was to decrease latencies and increase errors. Thus, merely manipulating the time factor externally does not replicate reward effects. Imposing specific external time constraints upon the subject does not appear to be the same as responding more slowly for internal reasons. Indeed, when the results of Experiment 2 are viewed in relation to those of Experiment 1, it would appear that the introduction of an external control (miniature railroad signal) effectively converted the task into a reaction-time task. For this reason, the question concerning the role of response latency, and ultimately the role of rewards in the intenalization process, remains unanswered.

We find it interesting to consider the present results in light of White's (1965) concept of temporal stacking. White proposed a two-factor theory consisting of an associative level that develops early in life and depends on simple associative learning, and a cognitive level that develops later, between 5 and 7 years of age. White con-

sidered these two levels to be "temporally stacked," such that when a stimulus is presented, the ontogenetically prior associative level will be tapped first and, unless inhibited, will provide a response that may not be as effective as one from the later-developing and slower-to-respond cognitive level. The young child must react at the associative level, but the older child and the adult can respond at either level. The distinction that White has drawn between these two levels meshes with Hasher and Zacks (1979) contention that attentional demands occur along a continuum from effortful to automatic processes. This distinction is also consistent with the regression model which holds that the older, more stable, genetically-based processes (e.g., automatic) do not change, but that the newer, more sensitive cognitive processes (e.g., effortful) may regress to childlike habits of response.

In White's view, behavior is organized in a temporally-stacked hierarchical structure derived from competing stimulus-response connections. If White's idea were to be expanded to include a level of "evolutionary stacking," then what White has called Levels I and II could be considered Levels II and III; a new Level I would then consist of innate behavior. White's concept of temporal stacking, from this liberalized perspective, could offer one possible explanation for the results of Experiment 2. That is, reward may cause the subject to shift from a predominately cognitive modality toward a more associative one, and thereby influence the way of reacting. The idea that reward might produce such a developmental regression in the subject has recently been suggested by Fabes, Moran, and McCullers (1981). Such a viewpoint would be consistent also with the idea that the young child and the elderly subject may be under control of similar brain mechanisms.

There has been little interest in the concept of temporal stacking in recent years. However, one can see a logical connection here both to Luria's (1966) ontogenetic model of brain development and MacLean's (1978) phylogenetic model of the triune brain. Luria has identified three major units of the brain which develop in a hierarchical order at different times, while MacLean's model consists of three brains in one: the reptilian brain, the paleomammalian brain, and the neomamamlian brain. Thus, Luria's and MacLean's models indicate that those things that occur first in either ontogenetic or phylogenetic development ought to be "stacked" in first. Anything that is done to the individual to inhibit first-stacked responses ought to increase the likelihood that later-developing, more mature responses will occur. The railroad signal in the present study had the unexpected effect of speeding-up responding and increasing error. Nevertheless this result would still be consistent with a temporal stacking and regression conception in that faster responding leads to less mature behavior.

References

Dixon, W. J. (Ed.). Biomedical computer programs. Berkeley: University of California Press, 1975.

El'konin, D. B. Toward the problem of stages in the mental development of the child. Soviet Psychology, 1972, 10, 225-251. (Voprosy Psikhologii, 1971, 4, 6-20.)

Fabes, R. A., Moran, J. D., & McCullers, J. C. The hidden costs of reward and WAIS subscale performance. American Journal of Psychology, 1981, 94, 387-398.

Galperin, P. Y. On the notion of internalization. Soviet Psychology, 1967, 5, 28-41.

Galperin, P. Y. Stages in the development of mental acts. In M. Cole and I. Maltzman (Eds.), A handbook of contemporary Soviet psychology. New York: Basic Books, Inc., 1969.

Hasher, L., & Zacks, R. T. Automatic and effortful processes in memory. Journal of Experimental Psychology, 1979, 108, 356-388.

Herrick, C. Judson. The evolution of human nature. Austin: University of Texas Press, 1956.

Kagan, J. Reflection - Impulsivity: The generality and dynamics of conceptual tempo. Journal of Abnormal Psychology, 1966, 71, 356-388.

Klahr, D. Nonmonotone assessment of monotone development: An information processing analysis. In S. Strauss and R. Stavey (Eds.), U-shaped behavioral growth. New York: Academic Press, 1981.

Kopp, C. B. Antecedents of self-regulation: A developmental perspective. Developmental Psychology, 1982, 18, 199-214.

Leont'ev, A. N. The development of voluntary attention in the child. Journal of Genetic Psychology, 1932, 40, 52-83.

Lepper, M. R., & Greene, D. Overjustification research and beyond: Towards a means-end analysis of intrinsic and extrinsic motivation. In M. R. Lepper and D. Greene (Eds.), The hidden costs of reward. Hillsdale, N.J.: Laurence Erlbaum Associates, 1978.

Loveland, K. K., & Olley, J. G. The effect of external reward on interest and quality of task performance in children of high and low intrinsic motivation. Child Development, 1979, 50, 1207-1210.

Luria, A. R. Higher cortical functions in man. New York: Basic Books, 1966.

MacLean, P. A mind of three minds: Educating the triune brain. In J. S. Chall and A. F. Mirksy (Eds.), National society for the study of education yearbooks (Vol. 77, Pt. 2). Chicago: University of Chicago Press, 1978.

McLoyd, V. C. The effects of extrinsic rewards of differential value on high and low intrinsic interest. Child Development, 1979, 50, 1010-1019.

Pavlov, I. P. Conditioned reflexes and psychiatry. New York International Publishers, 1941. (Originally published in 1928.)

Posner, M. I., & Snyder, C. R. Attention and cognitive control. In R. L. Solso (Ed.), Information processing and cognition: The Loyola Symposium. Hillsdale, N.J.: Erlbaum, 1975.

Pribram, K., & McGuinness, D. Emotion and motivation in attention. In M. Wittrock (Ed.), The brain and psychology. New york: Academic Press, 1980.

Sarafino, E. P., & Stinger, M. A. Developmental factors in the undermining effect of extrinsic rewards on extrinsic interest: Do young children overjustify? Journal of Genetic Psychology, 1981, 138, 291-299.

Shiffrin, R. M., & Schneider, W. Controlled and automatic human information processing: II. Perceptual learning, automatic attending, and a general theory. Psychological Review, 1977, 84, 127-190.

Vygotsky, L. S. Internalization of higher psychological functions. In M. Cole, V. John-Steiner, S. Scribner, and E. Souberman (Eds. and trans.), Mind in society. Cambridge, Mass.: Harvard Press, 1978. (Unpublished manuscript, reprinted from Tool and Symbol in Children's Development, 1930.)

Vygotsky, L. S. Problems of method. In M. Cole, V. John-Steiner, S. Scribner, and E. Souberman (Eds. and trans.), Mind in society. Cambridge, Mass.: Harvard Press, 1978. (Reprinted from The History of the Development of Higher Psychological Functions. Moscow, 1960.)

Vygotsky, L. S. The development of higher forms of attention in childhood. Soviet Psychology, 1979, 18, 67-115. (Originally published in 1929.)

Werner, H. Comparative psychology of mental development. New York: Science Editions, 1961.

White, S. H. Evidence for a hierarchical arrangement of learning processes. In L. P. Lipsitt and C. C. Spiker (Eds.), Advances in child behavior and development (Vol. 2). New York: Academic Press, 1965.

Wozniak, R. H. Verbal regulation of motor behavior: Soviet research and non-Soviet replications. Human Development, 1972, 15, 13-57.

Yendovitskaya, T. V. Development of attention. In A. V. Zaporozhets and D. B. El'konin (Eds.), The psychology of preschool children. London: MIT Press, 1971.

Zaporozhets, A. V. The development of voluntary movements. In B. Simon (Ed.), Psychology in the Soviet Union. Palo Alto, Calif.: Stanford University Press, 1957. (Originally published in 1955.)

Zivin, G. Removing common confusions about egocentric speech, private speech, and self-regulation. In G. Zivin (Ed.), The Development of self-regulation through private speech. New York: Wiley, 1979.

Footnotes

[1] Many of the references to Soviet literature were first published in the 1930's in Russian journals and are just now appearing in the English language journals. In some cases, work that was never published before is now appearing in English language translation, long after the author's death. For example, Vygotsky's definition of internalization cited here was taken from one of his essays: "Tool and Symbol in Children's Development" (1930), which has never been published. The use of dual dates in the text and other devices in the list of references was done to minimize possible reader confusion on this point.

[2] The fourth series of questions in Leont'ev's study, used only for teaching purposes, was omitted in the present study.

[3] Unless otherwise noted, all data were analyzed via ANOVAS using the BMD P2V computer package (Dixon, 1975).

[4] The same relationship of errors and latency scores as reported for aids and no aids was also present for reward and no reward.

[5] A t-test performed on these data yielded a nonsignificant difference, $t(26) = 1.48$, between the two school populations which suggested some compatibility between the two types of schools.

[6] Repeated measures were not used in Experiment 2, since at this point it was not known whether the zero-second condition would have an interactive effect with the three-second condition; thus, the between-subjects design was used to control for this possibility.

[7] The mean error scores were adjusted so that Experiment 1 data could be compared with those of Experiment 2. Specifically, the total number of correct responses on the color questions were divided by the total number of color questions. In Experiment 1, the total number of color questions was 7; in Experiment 2, it was 10.

Table 1

Questions Utilized in Experiment 1

and A. N. Leont'ev's Study[a]

Series I:	Practice condition (No constraints)
1.	Do you like to draw?
	[Can you draw?]
(2.)[b]	What color is a handkerchief?
	[What color is your handkerchief?]
3.	Did you ever go in an airplane?
	[Did you ever go in the tram?]
(4.)	What color is the airplane?
	[What color is the tram?]
5.	Do you like to study?
	[Do you want to study?]
6.	Did you ever go to a meeting?
	[Were you ever at a meeting?]
7.	Do you like books?
	[Do you like reading?]
(8.)	What color is the paper?
	[What color is the paper?]
(9.)	What color are the pencils?
	[And pencils?]
10.	Do you play with games?
	[Do you play with toys?]
11.	Have you seen the ocean?
	[Have you seen the sea?]
(12.)	What color is the ocean?
	[What color is the sea?]
13.	Do you ever listen to music?
	[Did you ever listen to music?]
14.	Have you seen vegetables growing?
	[Have you seen vegetables growing?]
(15.)	What color is lettuce?
	[What color are cucumbers?]
16.	Do you like dogs?
	[Do you like dogs?]
(17.)	What color are cats?
	[What color are cats?]

Table 1 (Continued)

18	What do you do with a saw? [What does one do with a saw?]
Series II:	No aid condition ("Forbidden colors" were green and yellow)
1.	Have you a friend? [Have you a playmate?]
(2.)	What color is your shirt (blouse)? [What color is your shirt?]
3.	Did you ever go on a train? [Did you ever go in a train?]
(4.)	What color are the train engines? [What color are the railway carriages?]
5.	Do you want to be a bigger boy (girl)? [Do you want to be big?]
6.	Were you ever at the movies? [Were you ever at the theatre?]
7.	Do you like to play in your room? [Do you like to play in the room?]
(8.)	What color is the floor? [What color is the floor (generally)?]
(9.)	What color are the walls? [And the walls?]
10.	Do you write? [Can you write?]
11.	Have you seen violets? [Have you seen lilac?]
(12.)	What color is violet? [What color is lilac?]
13.	Do you like cookies? [Do you like sweet things?]
14.	Were you ever in the mountains? [Were you ever in the country?]
(15.)	What color are leaves? [What colors can leaves be?]
16.	Do you swim? [Can you swim?]

Table 1 (Continued)

(17.) What is your favorite color?
[What is your favorite color?]
18. What do you do with a pencil?
[What does one do with a pencil?]
What do you think? Did you get them all right? What should you not have said? And what else?

Series III: Aid condition ("Forbidden colors were blue and red)
1. Do you sometimes take walks?
[Do you sometimes go for walks in the streets?]
(2.) What color are the houses?
[What colors are the houses?]
3. Does the sun shine brightly?
[Does the sun shine brightly?]
(4.) What color is the sky?
[What color is the sky?]
5. Do you like candy?
[Do you like candy?]
6. Have you seen roses?
[Have you seen roses?]
7. Do you like vegetables?
[Do you like vegetables?]
(8.) What color are tomatoes?
[What color are tomatoes?]
(9.) What color are notebooks? Tablets?
[And what color are exercise-books?]
10. Have you any toys?
[Have you any toys?]
11. Do you play ball?
[Do you play ball?]
(12.) What color are balls?
[What colors are balls?]
13. Do you live in the city (town)?
[Do you live in the town?]
14. Have you watched a parade?
[Did you see the demonstration?]

Table 1 (Continued)

(15.) What color are flags?

[What color are flags?]

16. Have you any books?

[Have you a book?]

(17.) What colors are their covers?

[What color is the book-cover?]

18. When does it get dark?

[When does it get dark?]

What do you think? Did you get them all correct? What should you not have said? And what else? Did the cards help? Why

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[a]Leont'ev's (1932) original questions are given below the present study questions in brackets.

[b]Scored questions are given in parentheses.

Table 2

Mean Numbers of Errors and Standard Deviations for Each Age Level by Reward and Aid Conditions, Shown With Leont'ev's (1932) Means for Comparison Purposes

Present Study												Leont'ev			
		Reward					Nonreward								
Age	n	Series II (No Aid)	S.D.	Series III (Aid)	S.D.	n	Series II (No Aid)	S.D.	Series III (Aid)	S.D.	Age	n	Series II (No Aid)	Series III (Aid)
4-5 years	12	3.08	1.62	3.25	1.29	12	3.58	1.51	4.5	1.17	5-6 years	7	3.9	3.6
6-7 years	12	1.75	1.14	2.17	1.40	12	2.42	1.31	2.83	1.90				
8-9 years	12	1.08	0.79	0.67	0.98	12	1.50	1.09	1.08	1.31	8-9 years	7	3.3	1.5
10-12 years	12	0.75	0.62	0.50	1.00	12	1.00	0.95	0.83	1.47	10-13 years	8	3.1	0.3
18-30 years	12	0.50	0.90	0.17	0.39	12	0.08	0.29	0.33	0.49	22-27 years	8	1.4	0.6
64-85 years	12	1.75	1.06	2.83	1.11	12	1.58	1.24	2.00	1.65				

Table 3

Mean Numbers of Responses and Mean Correct Response Latencies in seconds (Upper Table)

Mean Numbers of Errors and Mean Error Latencies (Lower Table)

for Experiment 1 and Experiment 2 (Adjusted Scores)

Group[a]	n	Aid				No Aid			
		Correct Responses	SD	Correct Response Latency	SD	Correct Responses	SD	Correct Response Latency	SD
0-sec	16	7.69	1.85	5.58	6.42	6.87	1.78	3.55	4.20
3-sec	18	8.22	1.31	6.22	3.46	7.33	1.03	5.22	2.81
Nonreward	12	8.45	1.87	10.73	4.84	7.98	1.66	7.74	3.00
Reward	12	9.05	1.41	9.88	2.95	8.45	1.13	8.94	2.85
		Errors	SD	Error Latency	SD	Errors	SD	Error Latency	SD
0-sec	16	2.31	1.85	8.84	11.28	3.13	1.78 (12)	4.35	5.75
3-sec	18	1.78	1.30	9.67	10.29	2.67	1.03 (15)	7.4	7.29
Nonreward	12 (7)[b]	1.08	1.31	6.48	4.24	1.50	1.09 (11)	8.60	6.09
Reward	12 (5)	0.67	0.98	11.97	10.17	1.08	0.79 (9)	9.78	7.0

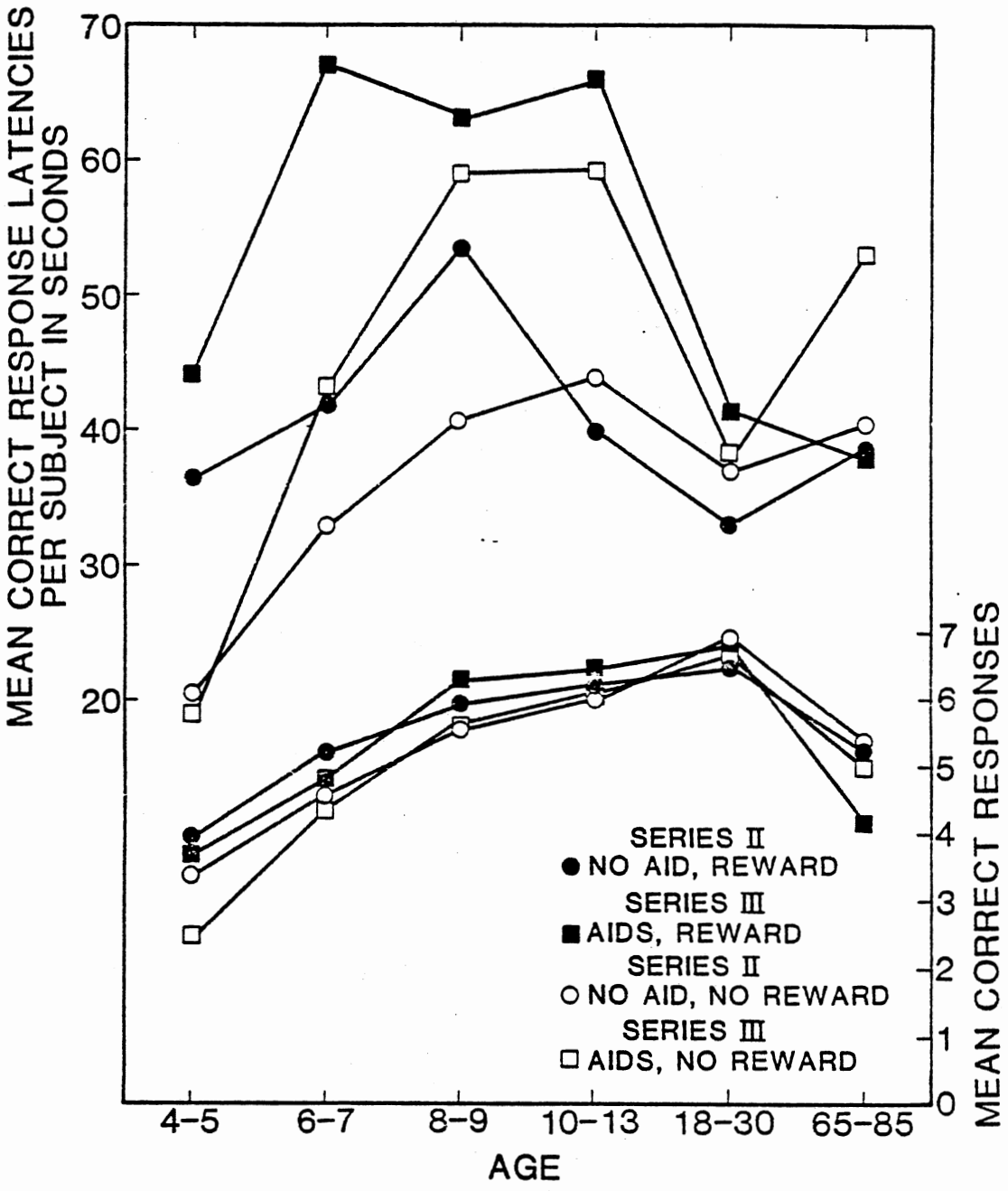
[a]Third-grade children only.

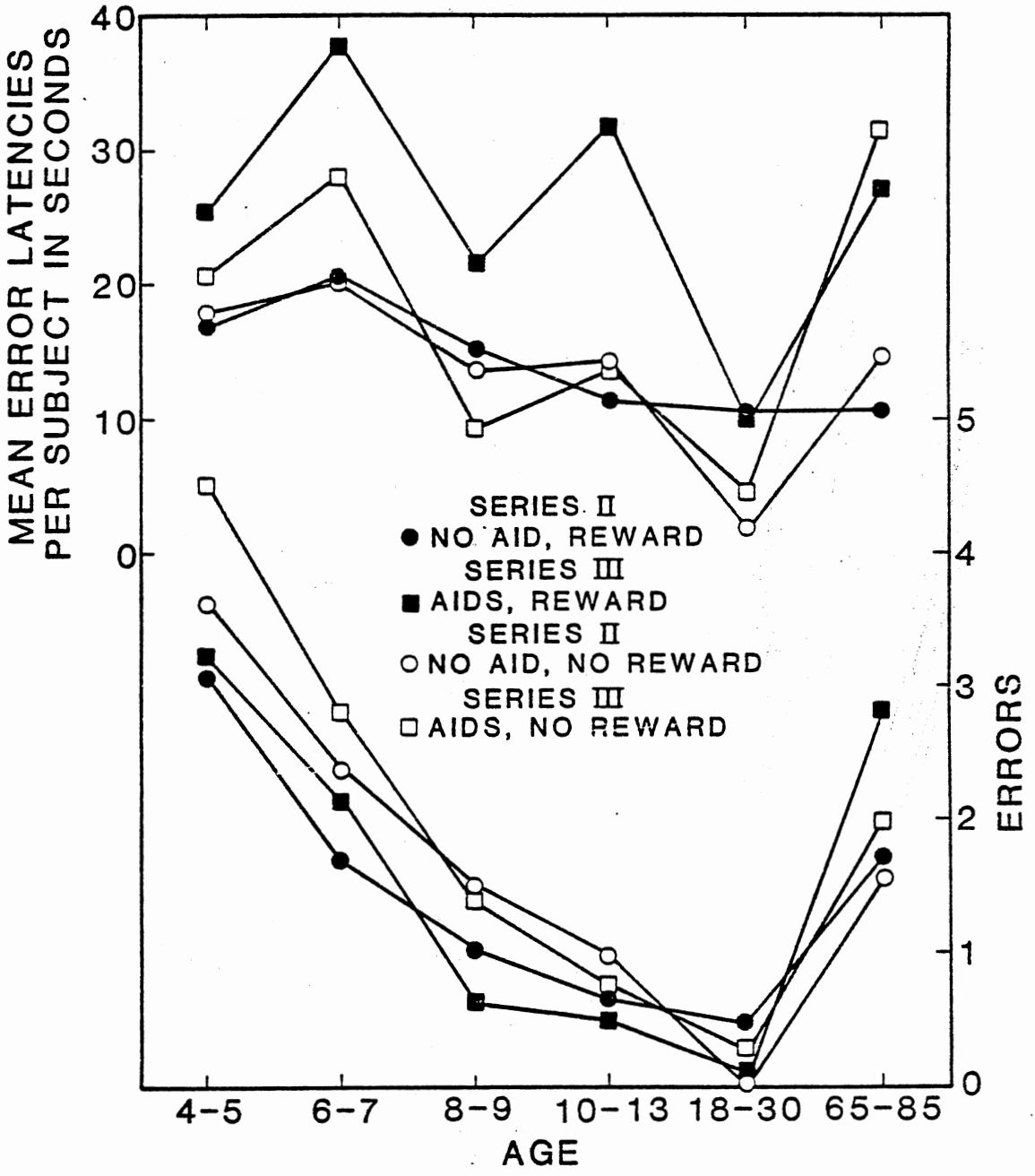
[b]Numbers in parentheses indicate the number of children who made errors.

Figure Captions

Figure 1. Correct response data for Series II (No Aids) and III (Aids) under reward and nonreward conditions. The upper four curves show the mean correct response latencies in seconds (read against the left-hand vertical axis) as a function of age. The lower four curves show the mean numbers of correct responses (read against the right-hand axis) made by each age group.

Figure 2. Error data for Series II (No Aids) and III (Aids) under reward and nonreward conditions. The upper four curves show the mean error latencies in seconds (read against the left-hand axis) as a function of age. The lower four curves show the mean numbers of errors (read against the right-hand axis) made by each age group.


MEAN CORRECT RESPONSE LATENCIES
PER SUBJECT IN SECONDS
70
60
50
40
30
20
MEAN CORRECT RESPONSES
7
6
5
4
3
2
1
0
4-5
6-7
8-9
10-13
18-30
65-85
AGE
SERIES II
NO AID, REWARD
SERIES III
AIDS, REWARD
SERIES II
NO AID, NO REWARD
SERIES III
AIDS, NO REWARD


MEAN ERROR LATENCIES
PER SUBJECT IN SECONDS
40
30
20
10
0
5
4
3
2
1
0
ERRORS
SERIES II
NO AID, REWARD
SERIES III
AIDS, REWARD
SERIES II
NO AID, NO REWARD
SERIES III
AIDS, NO REWARD
4-5
6-7
8-9
10-13
18-30
65-85
AGE

APPENDIX A

LITERATURE REVIEW

Historical and Theoretical Perspective of Soviet Psychology

The purpose of this section is to present the philosophical background within which Vygotsky's theory of internalization arose, and to discuss the concept of internalization as developed by Vygotsky, so that the Soviet research concerning this concept and the related American research can be evaluated in their proper context.

Russian psychology has its roots in, and still derives its basic tenets from, dialectic materialism:

> "Materialism," that is the assumption that we have exact knowledge of a physical and psychological reality, which exists independently of man's perceptions of it; "dialectics," that is the notion that everything is in flux with no self-existent autonomous entities which are unchangeable. (McLeish, 1975, p. 264)

The Russian psychologists have translated into concrete terms certain well-known philosophical propositions of Marxism-Leninism which indicate that the psychological development of individuals follows a path that is social in origin (e.g., Luria, 1979; Vygotsky, 1929). They have built their psychology around the Marxist tenet that the human psyche is a reflection of an objective reality, in particular, the social environment. In Lenin's (1929) words: "Every concrete thing, every concrete something, stands in multifarious and often contradictory relations to everything else; ergo it is itself and some other" (p. 124). Thus, Lenin (1909) proposed that the psyche is the property of the most highly organized form of matter--the brain--and that the psyche is a reflection of external reality.

In order to have a respect for, and an understanding of, Soviet psychology, one must remember that there is a two-fold requirement for the psychologist: first, that Soviet psychology be based philosophi-

cally on dialectical materialism; and secondly, that it be based on Ivan Pavlov's (1928) physiology of the higher nervous activity. That is, Soviet psychology seems to have as its foundation two basic pillars--on one pillar rest the teachings of Marx (e.g., 1906-1909), Engels (1940), and Lenin (e.g., Lenin, 1929); on the other, the work of Sechenov (e.g., Sechenov, 1863/1942) and Pavlov (e.g., Pavlov, 1928).

The Russian school of objective psychology essentially derives its beginnings from Sechenov (1935/1973). The study of voluntary activity can be directly traced to Sechenov's analysis of reflex activity. His approach may have been the first plan for an objective psychology, if we consider that it was an investigation of the integral reflex-like mental process by means of an objective method in a system of interaction between organism and environment (Yaroshevski, 1968). From Sechenov's work came the foundation for Ivan Pavlov's experiment with dogs. Central to Pavlov's approach was the assumption that both animal and human behavior are evoked by an elementary system of signals (or stimuli) called by Pavlov (1928) the primary signal system. Pavlov also talked about a secondary signal system (not verified by Pavlov's research) that is based on the primary system and eventually comes to maturity in the human. To quote from Luria and Yudovich (1971):

> The transition from the animal world to the stage of man signifies the introduction of a new principle of development. At the animal stage, the development of higher nervous process in each species is the outcome of individual experience, but with the transition to man, the basic form of mental development becomes the acquisition of the experience of other people through joint practice and speech. (p. 22)

Vygotsky entered upon the scene in 1928 with a cultural-historical

theory, adapted from Blonsky's statement that the "theory of behavior should be a theory of the history of behavior" (cited in Rahmani, 1973, p. 38). Thus, Vygotsky (1929) formulated his primary thesis:

> In the process of development the child not only masters the items of cultural experience, but the habits and forms of cultural behavior, the cultural methods of reasoning. We must, therefore, distinguish the main lines in the development of the child's behavior. First, there is the line of natural development of behavior which is closely bound up with the processes of general organic growth and the maturation of the child. Secondly, there is the line of cultural improvement of the psychological function, the working out of new methods of reasoning, the mastering of the cultural methods of behavior. (p. 415)

Vygotsky extended his theory by incorporating and extending Engels' notion of mediation by tools to mediation by signs. For example, Engels (1940) writes:

> When after thousands of years of struggle the differentiation of hand from foot, and erect gait, were finally established, man became distinct from the monkey and the basis was laid for the development of the brain that has since made the gulf between man and monkey an unbridgeable one. The specialization of the hand--this implies the tool, and the tool implies specific human acitivty, the transforming reaction of man on nature, production. (p. 17)

Vygotsky, along with Rubinstein, played a prominent role in the new psychology movement (beginning in the 1930's and evolving into what is essentially the nucleus of the contemporary Soviet approach to thought, language, memory, etc.) which attempted to define man primarily as a conscious and active being. Their postulates were manifested mainly in the field of mental development of the child which was one of the major foci of the Soviet psychologists in the 1920's and 1930's.

Another psychologist, Alexander Luria, had been working at the Institute of Psychology in Moscow and met Vygotsky in Leningrad in 1924 at a psychological Congress. After the meeting, Luria invited Vygotsky

to join Leont'ev and himself at the Institute of Moscow. They planned the development of psychological science together and talked about what direction psychology should take in this cooperative venture.

When Vygotsky, Luria and Leont'ev joined forces world psychology was in a state of confusion. Psychology was divided into two isolated fields. In one area, there was the research of Pavlov and Bekhterev on the physiological mechanisms that underlie behavior, and on the other, the more complex forms of man's conscious mental activity, such as abstract thinking, deliberate remembering, and voluntary attention.

At this point in time, Vygotsky provided a theoretical perspective to the problem. He put forth the idea that even the most complex psychological processes are based on the combination of elementary reflexes, but he felt that attempts to reduce mental activity to a system of reflexes was not the logical way to proceed (Rahmani, 1973).

This triad of Russian psychologists, Leont'ev, Vygotsky, and Luria (known as the "troika"), have embodied Lenin's and Engels' principles in expounding their theories and were early advocates of combining experimental cognitive psychology with neurology and physiology. They have essentially laid the foundation for a unified behavioral science.

In sum, then, an understanding of Soviet psychology presupposes an appreciation of the basic philosophical social positions on which it is founded. (Although Soviet psychology functions within the constraints of the Bolshevik interpretation, Soviet writings and research can be evaluated without reference to their background; nonetheless, they are an integral part of the general striving toward the development of a materialistic psychology.) There appears to be a distinct interrelation between the philosophical and specific theoretical and experi-

mental approaches in Soviet psychology. Vygotsky's postulates substantiate this point. The development of his thoughts in terms of the role of "signs" in human development directly emerged from his goal in attempting to overcome mechanistic tendencies in the Russian psychology of the 1920's and formulate a theory based on Engels' (1940) proposition that man changes as a result of tool using. Marx (1906-1909) also emphasized tool use and wrote:

> An instrument of labour is a thing, or complex of things which the labourer interposes between himself and the subject of his labour, and which serves as the conductor of his activity. . . .The use and fabrication of instruments of labour, although existing in the germ among certain species of animals, is specifically characteristic of the human labour-process, and Franklin therefore defines man as a tool-making animal. (pp. 199-200)

Further, the modification of Vygotsky's theses by Galperin (1969), Leont'ev (1972/1979, 1981), and Luria (1961) led to the development of new theories.

The Russian school of psychology, then, took its lead from Sechenov's work in voluntary activity and inhibition, continued with Vygotsky, and was substantiated by Alexander Luria until his death in 1977. Closely linked with this physiological-theoretical-scientific framework developed by Luria and Vygotsky is the question of the psychological development of the child. The psychology of development is based on Pavlov's principle of the uniting of internal and external conditions. Training and education become particularly important in the scheme of operations underlying the moral and intellectual development of the child.

The problem of the relationship between thought and speech in the

organization of behavior constitutes the central area of research for Soviet psychology, since communication is the crux of socialization.

Summary of Soviet Perspective in Contrast to Western View

Several areas are primarily focused upon Soviet theory (Payne, 1968): (1) Soviet theory is first and primarily, particularly since the Pavlov movement, a developmental-learning-experimental theory. Thus, warm-up and training procedures are central aspects of any experiment. Western psychology, in contrast, has tended to view warm-up as a routine brief procedure, aimed at assuring minimal comprehension of the task at hand for the subject. In replications of Soviet research by American psychologists, differences in warm-up and preliminary training could prove to be a source of difficulty. (2) Soviet theory is also a theory of language function. The experimenter must consider his use of language with the child a significant part of the experiment. The experimenter's language in the instruction is as important as the child's own language in responding to the task. Western psychology, however, has tended to view instructions to the child as something given once at the beginning of an experiment as a means of conveying at one time all of the information the child will need for the entire procedure. Instructions often are lengthy and difficult for the child to remember. If internalization of instruction is a crucial factor in the development of verbal regulation of behavior, complex instructions given only initially might well fail to have the desired effect. The examiner's instructions, external to the child, are viewed by Luria and others as a conceptual tool which the child can eventually internalize and use as a means of self-control. (3) Lastly, Soviet theory is

an adult-interaction theory, and this, coupled with a general orientation to the clinical-neurological method, allows freedom for the experimenter to explore the behavioral dynamics of an individual in an undefined manner. Western psychologists view this clinical method in the experimental situation as a weakness since input to subject is not standardized or easily quantified. Statistical treatment of data is just beginning to be utilized in Soviet studies. Additionally, Soviet psychologists have little to do with and have little appreciation of psychological tests of intelligence, aptitude, and achievement, etc., which, in some respects, may account for their more qualitative approach in contrast to the more quantitative approach of American psychologists (e.g., Reitan & Davison, 1974).

There appear to be three established main trends and an emerging fourth trend in current Soviet psychology (O'Connor, 1966): (1) Pavlovian studies of conditioning as related to higher central nervous functions; (2) studies of the verbal control of behavior emanating from Vygotsky's findings; (3) Georgian "set" theory based on Uznadze's work (a special school of personality theory centered around the set as inclination directedness, and readiness to perform an act leading to the fulfillment of a need); (4) the application of statistical and cybernetic techniques.

Soviet psychologists, in their study of human behavior, lay stress on the role of the social environment which is what investigators in the West might call social psychology, except there is an empahsis upon the historical (developmental) approach, both phylogenetically and ontogenetically. Additionally, Leont'ev's theory of activity provides the framework within which most of the psychological research is ac-

complished (Wertsch, 1979, 1981). In the Soviet perspective, goal-directedness plays an important role in the deciphering of behavior. Soviet psychologists criticize the American researchers for not considering the goals in conjunction with the actions of the child. All in all, it appears that the direction of psychological research in the U.S.S.R. is not too different from our own, except for their emphasis on consciousness and higher nervous activity within a developmental perspective.

The Concept of "Internalization"

Vygotsky's concept of internalization possibly originiated in the French school of sociology, where Durkheim and Mauss (1963) considered that the basic mental processes are not the results of the inner spirit or of evolution, but rather find their origins in society. This conception suggested that even such simple behaviors as telling time are the result of man's social experience and are dependent on social consciousness. This viewpoint meshes with the idea of Fichte (1922), that the external world is merely the product of one's ego. More recently, Leont'ev (1972/1974-1975) had indicated that "internalization, by which external actions are transformed into internal actions, is made possible by the similarity of structure of internal and external activities" (p. 21).

Other authors have examined the problem of internalization or the transfer of external stimuli to an internal level. Kretschmer (1925) viewed the law of nervous acitivty in terms of the process. Watson (1924/1970) hypothesized that thought was a direct conversion of overt, external processes to covert, internal ones; that is, "verbal behavior→

whisper→ totally unvoiced behavior. Thereafter he carries the world around with him by means of this inner organization" (Watson, 1924/1970, p. 234). Piaget (1973) stressed the role of internalization in terms of symbolic functions: "Thus the symbolic function makes this interiorization of actions possible or at least strengthens it considerably" (p. 74). The question of how this process occurs from the sensory level to the higher mental functions has not been resolved. Tolman (1932) has indicated that the effects of external influences depend on the psychological intervening variables that are associated with the person's inner states.

In the Soviet realm, the concept of internalization probably had its origins in Herbert Spencer's (1895) hypothesis which involved a duality of factors: the external influences of the environment and their modification by the neuropsychological organization. In Spencer's (1895) words: "...The conception of life itself, as the continuous adjustment of inner relations to outer relations--a conception which was found to include at once the phenomena of bodily life and the phenomena of mental life--introduces us to an entire agreement between the general aspect of mental phenomena as objectively considered, and the general aspect of mental phenomena as subjectively considered" (p. 505w). Drawing on Spencer's ideas, Sechenov (1935/1973) set the stage for his study of mental processes as related to external factors (or the process of internalization):

> If Spencer's hypothesis of the duality of the factors of evolution is true, then the neuro-psychical organisation of man can be influenced, during the whole course of its evolution, only by external factors; under the action of these, the reactions (and thereby the structure) of this organisation must change, giving birth to thought in all its complexity, i.e., with all its various objects,

> with its progress from the concrete to the abstract, from the general to the special, from the sphere of sensory facts to that of extra-sensory contemplations, etc. Consequently, the possibility of the transformation of impression into thought (both in form and contents) must be present either in one of the above mentioned main factors of mental development of thought, or in their interaction. Further, if it is true that the process of mental evolution follows the laws of organic evolution, then the transformation of sensation into thought must be limited to a disintegration of homogeneous impressions into their elements and the re-combination of these elements into groups. In other words, either the neuro-psychical organization, or the external influence or, finally, the cooperation of both factors must contain the conditions that are necessary for the analysis and synthesis of whole or partial impressions. (p. 420)

According to Sechenov (1935/1973), then, the muscle serves as a tool connecting the subject with an object in the world, such that sensations of the world are essentially converted into thought. Thus, Sechenov demonstrated for the first time in the history of world thought, that sensory signals sent by the muscles reflect space, time, and movement forms of the world (Yaroshevski, 1968).

Sechenov's study of reflex activity and subsequently the differentiation of sensation and thought essentially served as the foundation for Pavlov's (1928) concept of internal inhibition versus external inhibition, which further laid the foundation for Vygotsky's scheme of internalization:

> By the great difference in facts we were compelled to assume in the work on the cerebral hemispheres two different kinds of inhibition, and we called them "external" and "internal." The former appears in our conditioned reflex at once; the second develops in time and is gradually elaborated. (p. 339)

From the psychological perspective, Pavlov (1928) based all forms of behavioral responses on the principle of relations between two opposing processes--excitation and inhibition. He indicated that the

behavior of the organism is dependent upon the balancing of the processes of excitation and inhibition to the various objects of the external world.

These concepts of inhibition versus excitation led the concept of the "second"-signal system which Pavlov designated as specific to man and constituted the symbolic representation of environmental stimuli (i.e., language), whereas, in the "first"-signal system environmental stimuli, through conditioning, come to signal other stimuli. The sum total of all these relationships, or as Pavlov has called them, "signals of signals," constitute the second signal system.

Vygotsky utilized this duality of factors, as represented by the internal environment and external environment and expounded by Sechenov and Pavlov, to create his theory of internalization. Whereas Sechenov (1935/1973) postulated a genetic approach to psychological processes based upon the processes of evolution, Vygotsky decided to go beyond the naturalistic study of man's mental processes and to interpret these processes as the product of socio-historical development. The idea that man is not only a product of his environment, but also an active agent in the creation of the environment became the cornerstone of his psychological methodology. An important means in this quantification was his theory of internalization which professed that the source of man's mental life is external to the individual and consists of the "internalization" of signs (e.g., speech) as a means of community interaction. Vygotsky (1960/1979, 1981) indicated that "external" means "social" (p. 162).

Vygotsky has been credited with introducing the psychological concept of internalization into the mainstream of Soviet psychology, al-

though the hypothesis that thinking essentially consists of an internalization of external acts of behavior was developed by Galperin (1969), a member of Vygotsky's school. Also, Rubinstein (cited in Leont'ev, 1972/1979, 1981) expressed it as follows: "External causes act through internal conditions" (p. 42). Vygotsky (1929) used the notion of internalization to mean the internalization of social processes, that is social interaction provides the control of what is to be internalized. Vygotsky (1960/1979, 1981) formulated the general genetic law of cultural development as follows:

> Any function in the child's cultural development appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane. First it appears between people as an interpsychological category, and then within the child as an intrapsychological category. This is equally true with regard to voluntary attention, logical memory, the formation of concepts, and the development of volition. We may consider this position as a law in the full sense of the word, but it goes without saying that internalization transforms the process itself and changes its structure and functions. Social relations or relations among people genetically underline all higher functions and their relationships. Hence, one of the basic principles of volition is that of the division of functions among people, the new division into two parts of what is not combined into one. It is the development of a higher mental process in the drama that takes place among people. Therefore, the sociogenesis of higher forms of behavior is the basic goal toward which the child's cultural development leads us. (p. 163)

According to Leont'ev (1972/1979, 1981), Vygotsky was led to the concept of internalization from his analysis of Engels' (1940) idea that human production in terms of labor was mediated by tools. Vygotsky (1930/1978b), then, wrote: "The tool's function is to serve as the conductor of human influence on the object of activity; it is externally oriented; it must lead to changes in objects. It is a means by which human external activity is aimed at mastering and triumphing

over nature. The sign, on the other hand, changes nothing in the object of a psychological operation. It is a means of internal activity aimed at mastering oneself; the sign is internally oriented" (p. 55).

Bear in mind that although Vygotsky focused upon the significance of cultural influences in cognition, he conceived of development as a complex intertwining of both biological aspects of behavior and socio-historical requirements of an individual's culture (1960/1978). In the attempt to determine what forms of activity underlie man's mental development, Vygotsky specifically focused upon auxiliary means (especially language) in social interaction. Vygotsky (cited in Cole, John-Steiner, Scribner, & Souberman, 1978, p. 127) provided many examples of auxiliary stimuli, particularly from nonindustrialized societies:

> Counting fingers was once an important cultural triumph of humankind. It served as a bridge between immediate quantitative perception and counting. Thus, the Papuas of New Guinea began to count with the pinky of their left hand, follow through with the remaining left hand fingers, then add the left hand, forearm, elbow, shoulder, and so on, finishing with the pinky of the right hand. When this was insufficient they often used another person's fingers, or their own toes, or sticks, shells, and other small portable objects. In early counting systems, we may observe in developed and active form the same process that is present in rudimentary form during the development of a child's arithmetical reasoning.
>
> Similarly, the tying of knots as a reminder not to forget something is related to the psychology of everyday life. A person must remember something to fulfill some request, do this or that, pick up some object. Not trusting his memory and unwilling to go by it, he often ties his hanky into a knot or uses a similar device, such as sticking a little piece of paper under the cover of his pocket watch. Later on, the knot is supposed to remind him of what he was supposed to do. And, this device often successfully carries out that function.
>
> Here, again, is an operation that is unthinkable and impossible in the case of animals. In the very fact of the introduction of an artificial auxiliary means of

> memorizing, in the active creation and use of a stimulus as a tool for memory, we see a principally new and specifically human feature of behavior. (p. 127)

Vygotsky applied a series of tasks to people of different ages to indicate how an external activity is transformed into internal operation. "The internalization of socially rooted and historically developed activities is the distinguishing feature of human psychology, the basis of the qualitative leap from animal to human psychology. As yet, the barest outline of this process is known." (1930/1978b, p. 57).

Vygotsky's theory appeared compatible with the tradition of Marx and Engels, in that the mechanism of individual developmental change is rooted in society and culture. Although Vygotsky's views were significantly more progressive and nearer to a Marxist understanding of mental development than were those of the reflexologists and the behaviorists in the late twenties, his theories were severely criticized by the Scientific-Research Sector of the Academy of Communist Education on three counts: "(1) the divorce of higher mental functions from their biological hearitage (mediated memory, attention, etc.); (2) the disregard of specific age periods in children's development; (3) an un-Marxist consideration of the process of historical development, not taking into account the concrete character of social formation, class struggle, etc." (El'konin, 1966/1967, p. 38).

In sum, Wertsch (1979, 1981) points out that Vygotsky's theory relies on three main factors: (1) he constantly depends on developmental explanation; (2) he develops the theme of the interrelation of cognitive functioning and social interaction; and (3) he analyzes the importance of the role played by mediational means in his framework.

Vygotsky's most important contribution lies in his method of ex-

perimental-genetic research, which presented a model for the study of human behavior, specifically the mental functions and processes from an historical perspective. In order to trace the development of the higher mechanisms of attention, the experimental-genetic method was used. This method involves an experimental situation in which the child is confronted with the task of mastering two sets of stimuli: one set is the primary set that has to be mastered and the other is an auxiliary set that could serve as a tool for mastering the primary set. This kind of experiment can be found in the writings of A. N. Leont'ev (e.g., 1932).

Leont'ev expanded upon Vygotsky's "internalization" theory in order to have it more completely mesh with Marx's tenets and he also developed the theory of activity. Leont'ev (1972/1979, 1981) declared that a social history of the mind should begin with Marx's (1906-1909) philosophy that the mastery of a certain class of tools is tantamount to the development of a certain group of abilities. It follows, then, that since an individual is exposed during the course of development to a world of objects, it is reasonable to assume that he assimilates the mental process and abilities realized in the world of objects. The development of the mind, then, consists of the internalization of the material and the spiritual objective products of human activity. Leont'ev (1972/1979, 1981) further argues that "...neither the external world nor the person is solely responsible for developing knowledge about the world" (p. 38). He postulates that the key to the internalization process is the activity in which that person engages. The concept of activity, thus, plays a significant role in Soviet psychology. Wertsch (1979, 1981) indicates that Leont'ev's most important contri-

bution to Soviet psychology is his levels of analysis hypothesis, whereby human activity can be analyzed in terms of three different levels, that is, a level of activity, a level of actions with their associated goals, and a level of operations. Hence, Leont'ev is analyzing the process, not objects.

Leont'ev's (1972/1979, 1981) concept of internalization can be briefly summarized in terms of the relationship between external and internal types of activity:

> Internalization is the term applied to the transition that results in the conversion of external processes with external material objects into processes carried out on the mental plane, on the plane of consciousness. In the transition these processes often undergo specific transformations--they are generalized, verbalized, abbreviated; most importantly, they can be developed further. This last factor allows them to exceed the limitations of external activity. (p. 55)

More recently, Leont'ev (1972/1979, 1981) has indicated that "these transitions are possible only because external and internal activity share a common structure. To me the discovery of this common structure represents one of the most important discoveries in modern psychology. Internal activity, which has arisen out of external, practical activity, is not separate from it and does not rise above it; rather it retains its fundamental and two-way connection with it" (p. 58).

A Review of Soviet Research as Related to Internalization

Now let us turn to more recent history in terms of the research on the process of internalization. Recent research regarding internalization has followed Vygotsky's experimental approach, that is, studying the mental process by breaking it down into different units or levels. For example, Leont'ev (1972/1979, 1981), who has followed up Vygotsky's

theory, has indicated that activity consists of three levels: activities, actions, and operations. These levels allow the researcher to analyze units of behavior from these three levels of activity. Western researchers have been particularly apt in doing this, but unlike the Russians who fit their research into Vygotsky's developmental framework, Western psychologists do not have any one framework within which to view their results. Additionally, Western psychologists essentially have studied the levels of analysis concerned with operations and have tended to exclude the levels of analysis concerned with actions and activities (Wertsch, 1979, 1981). Although the Soviet psychologists study memory, attention, and motivation as separate factors, they are purviewed within the context of internalization theory. According to Leont'ev (1959/1964), we can study these processes only if we consider that:

> Changes do not occur independently of one another but [are] intrinsically connected with one another. In other words, they do not represent independent lines of development of the various processes (perception, memory, thinking, etc.). . . .For example, the development of memory creates an associated series of changes, but the need for them is not determined by the relationships occurring within the development of memorizing itself but by relationships depending on the place which memory occupies in the child's activity at the given level of its development. (p. 184)

Thus, the following review will focus on the different units that contribute to the total internalization process with the main emphasis on memory and attention. But, bear in mind the "interrelation of the development of one facet of mental life with that of its other facets" (Smirnov, 1966/1973, p. 319). The question of the interactions of memory with thought, then, constitutes a very significant task for pscyhologists. First, we shall briefly scan the overall area of Soviet memory

research, then turn to specific memory research as related to external memonic aids with Leont'ev as the primary investigator. Finally, we shall attempt to relate reward to the total process. Smirnov (1966/1973) writes: "There is no doubt that of greatest importance is the dependence of mental processes on the external causes which have evoked them. But there is also no doubt that the very important role of external effects, if correctly understood, presumes an interrelation of the mental processes themselves" (p. 319).

Memory Studies: A General Overview

Among the leading contributors to Soviet research regarding memory are Leont'ev (1932), Blonsky (1935/1964), Zankov (1951/1957), Smirnov (1966/1973), Istomina (1948/1975), and Smirnov and Zinchenko (1969).

The Soviet view of memory emphasizes the subordination of actions to new goals so that the actions become operations in the service of accomplishing intentional goals, such as remembering (Meacham, 1977). Vygotsky (1960/1979, 1981) views the development of memory as similar to the development of the higher psychological functions. According to Vygotsky every higher mental process first passes through an "external" or "social" stage of development, then it is manifested psychologically; that is, it becomes intrapsychological (p. 163). Vygotsky's experiments have shown that the development of memory proceeds gradually undergoing transition from the initial, "natural" stage of memory to its higher psychological forms. For example, in one experiment with eight-year old children, each child was given several pictures and asked to press a specific button for each picture presented. Results

showed that the children made many errors since it was almost impossible for them to remember which button matched which picture. In a follow-up experiment to facilitate their remembering, the children were given external means. The external aids consisted of another set of pictures which had to be associated with the pictures pasted on the corresponding buttons. The children were able to make this association accurately since each pair of pictures was related by meaning (e.g., horse to sleigh, etc.); however, a younger child might simply assimilate the stimulus into his already learned chain of associations. For example, if "sleigh" was the reminder, then the child might respond by associating "snow" with "horse." When the experiments were repeated, the child's responses increased in speed. Vygotsky explains this result as being due to the fact that the child is no longer using external means (e.g., pictures) for his responses. Hence, the child's response mechanism has changed; that is, the remembering has been "internalized." Development thus proceeds from an external operation by means of external stimuli that act indirectly (pictures) to an internal operation which does not require such stimuli (Vygotsky, 1960/1979, 1981). At later ages (e.g., 10 years) then, the children could virtually create their own aids so that any auxiliary aid might be effective in facilitating memory.

Other researchers, Zaporozhets, Zinchenko, and El'konin (1971) indicated that memory depends on the character of the child's interaction with the surrounding environment. In the preschool age, remembering and recalling are achieved during the process of socializing with an adult and are primarily found in the form of recognition.

In a series of experiments, Smirnov (1966/1973) compared subjects

from preschool to adulthood in terms of involuntary and voluntary memory tasks. (Involuntary memory, as used here, means incidental, i.e., the child remembers without setting remembering as a specific goal, whereas voluntary memory is intentional.) Smirnov noted a strong trend in the direction of decreased relative efficiency of involuntary memory with increasing age. Smirnov's explanation was that comprehension of given material is easier for the older subject; thus, less intellectual activity is directed toward understanding and hence less effective involuntary memory.

As a result of other experiments focusing upon the role of understanding and memory, Smirnov (1966/1973) criticizes the idea that young children memorize mechanically. He found that the relative advantage of meaningful material decreases with age; older subjects are better able to give meaning to non-meaningful material. His experimental data support Leont'ev's contention that the specific activity is the key to understanding the process; that is, material directly concerned with the basic goal of an action is recalled better than material concerned with the condition for attaining a goal (Smirnov & Zinchenko, 1969); it is very important to take into consideration the way the subject interacts with the information. The idea that material that serves as the goal of an action is remembered better than material that is a part of the conditions for attaining a goal is based on Smirnov's (1945, 1948) research. (Research by Zinchenko [1962/1979, 1981] resembles American studies concerned with the "levels of processing" hypothesis [e.g., Craik & Lockhart, 1972]. This research has attempted to show that when verbal material is processed to varying "levels," memory retention varies.)

Children's remembering is considered to be controlled initially

by the structure of the external environment and not by activities engaged in for the purpose of remembering (Yendovitskaya, 1971). Children can do little to help themselves remember and the child's remembering occurs as a direct result of his daily experiences. With increasing age the child's remembering becomes defined as a goal within itself and comes under conscious control (voluntary memory), first by relying on external means of remembering and then on more advanced internal means. For example, the child may initially remember events only when questioned by the mother or interacting with her. This period of dependence upon external stimuli is important in Soviet developmental psychology, for this is the point in time that the child's activity can be controlled by the adult and the mnemonic skills specific to the culture can be conveyed to the child (Leont'ev, 1959/1964; Meacham, 1972; Yendovitskaya, 1971). According to Istomina (1948/1975), memory arises as an involuntary action in the service of other goals and in later childhood, functions as a goal in itself.

The following excerpt from Smirnov and Zinchenko's (1969) outline of the cognitive characteristics illustrates the interrelation of memory and cognitive development:

> In the first stage they are formed as a special purposive action and are not yet generalized; the fulfillment of these actions requires especially intensive conscious control. In the second stage, as a result of the transfer of actions to material of varying content, they begin to generalize. In the third stage, through further use they become, to a certain degree, automatized and acquire the form of generalized skills.
>
> The formation of mnemonic operations differs from the formation of cognitive processes in that it is always one stage behind cognitive processes when the latter are used as a means of remembering. . . .The initial use of a cognitive process for mnemonic ends becomes possible only when the individual can exercise a certain degree of freedom in operating with it.

> . . .(C)ognitive operations which become the means toward another activity first develop as goal-oriented processes and only later assume the characteristics of a distinctly intellectual skill. (p. 469)

In summary, it appears that Soviet researchers emphasize the importance of demands made in the context of social interactions as well as the types of activity in which the child is engaged; specifically, Vygotsky indicates that the development of memory is qualitative and proceeds in stages. In terms of development with preschool and elementary school children in the recall of pictures/words Smirnov and Zinchenko (1969) cited studies which indicated the following age characteristics:

(1) Recall increases and moves with age, that is, among preschool-age children a more significant increase is noted in the period from 4 to 5 years. In contrast, no significant differences are observed either between 3- and 4-year olds or between 5- and 6-year olds. Comparison of 8- to 9-year olds and 11- to 12-year olds show that the difference in recall was greater than that in comparable performances by 11- to 12-year olds and 14- to 15-year olds. (2) Not only speed, but also retention of recall increases with age. (3) Developmental levels in terms of recall and reproduction can be delineated as follows: (a) stage 1 in which children show no purposeful behavior in remembering; (b) stage 2 in which recall functions as purposeful behavior, that is, child sets a goal of remembering and actively attempts to carry out his intention, even though he lacks the appropriate means to do it; (c) stage 3 in which the child possesses methods which will facilitate recall, but the means are still not permanent and his methods mainly consist of verbalizing to himself by whispering.

Thus, 8- to 9-year olds do not show any substantial reserve of devices and their recall is largely spontaneous. In 11- and 12-year olds, analyses of memory processes show that children at this age often use mnemonic devices. Fourteen- to fifteen-year olds not only use a greater number of devices, but, more significantly, do so with more purpose and awareness. In sum, children show an increasing mastery of logical devices or methods of recall.

The Work of A. N. Leont'ev: Auxiliary Stimuli and Memory

The development of memory was the special province of A. N. Leont'ev, particularly in terms of the use of auxiliary or external stimuli. In his early research Leont'ev followed the maxims of Vygotsky very closely with respect to the internalization hypothesis and the experimental method (Rahmani, 1973). Leont'ev (1932) proposed that two forms of memory develop in the context of biological and cultural development: (1) an inferior, natural, nonmediated and involuntary memory dependent primarily upon natural processes, and (2) a superior, voluntary memory relying on generated, mental mediational processes. His studies were designed to test this assumption using Vygotsky's method of two sets of stimuli (double stimulation): objects to be memorized and mnemonic devices. The following experiments carried out by Leont'ev and his students provide good illustrations of the transition from externally mediated processes to internally mediated processes.

In one experiment conducted by Leont'ev (cited in Cole, John-Steiner, Scribner & Souberman, 1978), subjects ranging in age from preschool to adults were asked to memorize fifteen names of objects, while

in another condition, they were also asked to choose from a number of pictures representing the named objects. The pictures in this case served as an external means to remember. Results indicated that the young children were unable to utilize the external aids/mnemonic devices since their performance under both conditions was poor. The performance of the school children was considerably improved in the aid condition, while the adults showed few errors and no difference in the two conditions. The results of the adult group were interpreted to mean that at this stage the role of external means had been internalized in the form of words so that there was no difference between the presence or absence of the auxiliary stimuli (Vygotsky, 1930/1978c). According to Vygotsky (1930/1978c) the process of mediated memory is so fully developed for adults that it can occur with or without aids. These results suggest that memory rather than abstract thought is the evident characteristic in the early stages of cognitive development. Vygotsky (1930/1978c) further explains: "Toward the end of childhood, interfunctional relations with respect to memory reverse their directions. For the young child, to think means to recall; but for the adolescent, to recall means to think" (p. 51).

Another student and researcher, L. V. Zankov (cited in Cole, John-Steiner, Scribner & Souberman, 1978) demonstrated that younger children, between the ages of 4 and 6 years, must rely on meaningful, learned connections between the "reminder" signal and the word to be remembered. If the reminders presented were not meaningful as memory aids, the children would often not use them, but would transform these figures into concrete copies of the to-be-remembered word. For example, the figure  , presented as a reminder of the word "bucket"

was turned upside down by the children and served as a reminder of the word only when the figure really began to look like a bucket.

An unpublished study by V. C. Yussevich (cited in Cole, John-Steiner, Scribner & Souberman, 1978) yielded results similar to Zankov's study. The auxiliary stimuli, which were pictures and had no relation to the word presented, were seldom used as aids, but the child attempted to see the aid as the object to be remembered. For example, when one child was asked to remember the word "sun" with the aid of a picture showing an axe, she pointed to a yellow spot in the drawing and declared "There it is, the sun." Thus, the child replaced the meaningless auxiliary sign with a meaningful sign. What is significant in both the Zankov and Yussevich experiments is that the child produced the correct word through a mediation process that involved the use of a self-discovered, concrete representational cue but could not make use of the more abstract, symbolic cue provided by the experimenter.

Studies of Attention--Auxiliary Aids

The study of the development of the mental process, attention, reveals the same pattern as memory development. Vygotsky (1929/1979) pointed out: "When we speak of the cultural development of attention we mean evolution and change in the means for directing and carrying out attentional processes, the mastery of these processes, and their subordination to human control" (p. 69). With any of the cognitive processes studied within Vygotsky's framework, understanding is acquired through the study of those behaviors not from within but outside the child's personality. And so, it is with attention; social stimuli direct a child's attention. Vygotsky (1929/1979) explains:

> The key to the mastery of behavior can be found in the mastery of stimuli; and the cultural development of any function, including attention, consists of the fact that in the process of joint activity, the social human being develops several artificial stimuli. These artificial stimuli are signs that have the power to direct behavior. These signs become the basic means of the individual's mastering his/her own behavioral processes. (p. 70)

As a matter of fact, Vygotsky (1930/1978a) posits that attention should be the first among the major psychological functions underlying the use of tools to be studied. Galperin (1967) has hypothesized that voluntary attention evolves in a step-by-step process through the internalization of external experiences. Vygotsky (1929/1979) writes: Titchener's[1] "primary attention corresponds to our primitive or natural attention; his secondary attention corresponds to our stage of external mediation of attention; and, finally, his third stage correpsonds to our fourth stage. His analysis lacks only the second, transitional stage, a stage that is 'naively psychological'" (pp. 79-80).

Mozgovoy (1979) has noted that the development of attention is to a considerable extent governed by the importance or significance of an activity which, in turn, depends on the needs and interests of the individual, and also by the organization of the individual's activity, the learning of skills and aptitudes, and various other social factors. Vygotsky (1929/1979) has posed an interesting question: Why and how does our attention, which is initially subordinated to interest, subordinate interest to itself? At this time in our knowledge, the answer to this question remains unclear. In summary of his research findings concerning attention, Mozgovoy (1979) makes the following assumptions:

1. The formation of individual differences with regard to particular characteristics of attention takes place under a distinct genetic control.

2. The influence of genetic factors decreases progressively with age, evidently as the individual acquires more and more command over the voluntary regulation of activity.
3. Steadiness of attention continues longer than other parameters to be dependent on the genotype in ontogeny --possibly because of its correlation with the genotypically determined properties of the nervous system. (p.63)

A. N. Leont'ev (1932) in his studies of voluntary attention and memory found that children could facilitate the consistency of attention by using external aids and that adults could do the same with the employment of internal aids or mental faculties. For example, in Leont'ev's (1932) classic study of the development of voluntary attention, the mechanisms of attention are exemplified. In this experiment, the "experimental-genetic" method is utilized, where the subject is confronted with a situation which requires steadiness of attention on a specific process. (A description of this particular experiment appears on pages 10-12 of this report.) Essentially the experimental situation consists of presenting the subject with a specific task (e.g., to remember a list of words or to answer a list of questions constrained by specific rules to be remembered) aided by certain devices (e.g., pictures) that would facilitate the performance of the task. The experimenter, then, studies the results in terms of whether the subject used the aids/tools, and if so, how and in what way his activity changed and how this activity relates to his mental processes.

In sum, from the Soviet perspective, what the child develops in terms of memory/attention is a self-controlled system of strategies and operations for learning which has been internalized from the external environment. Vygotsky (1929/1979) stated that the content, structure, and functions of voluntary attention are the "result of changes and reorganizations of the whole developmental process under the influence of ex-

ternal stimulus means. . . .Voluntary and involuntary attention are related to one another just as logical memory is related to recognition or as conceptual thinking is related to prelogical thought" (p. 83).

The Role of Reward

From Vygotsky's viewpoint, any external stimuli may be considered a "second series of stimuli," such as external aids, if they can serve as the "psychological means" for an activity. Reward in this context gains clarification from a statement made by El'konin (1972): "In other words, mental processes (from elementary sensorimotor processes to higher intellectual processes) are dependent on the motives and tasks of the activity in which they are involved; they are determined by the place they occupy in the structure of the activity (the action or operation)" (p. 232). This concept of motive implicates the use of external rewards. It is after the case that certain conditions in the environment influence the way an action is carried out without giving rise to consciously recognized goals or subgoals. An experiment by Istomina (1948/1975) has investigated this issue in a study where the research question was to determine how the motives for the memorization affect the success of retention. A set of two experiments was explored. In one condition, preschool children were asked to repeat a number of words after the experimenter. Thus, memorization was carried on within the context of an experiment. In the other condition, the experiment was conducted in the course of a play activity, where the children played "store" and "buying" for the kindergarten a number of objects. These objects were labeled for the child and these labels were approximately the same as

were those memorized in the laboratory. Results showed that the effect of memorization in the second/natural condition was higher than in the first condition. Thus, practice under conditions of play activity was more evident than in the laboratory experiment and was especially noticeable in the younger children. Thus, the role of external reward may be considered in terms of the motives and tasks of the activity involved. These data, then, show that when children had a motive for memory which was clear to them, recall was more easily attained. Also this experiment illustrates how the Soviet researchers conceive of the interrelation between cognition and memory.

For Vygotsky, the chief problem was to study the mental processes themselves and motivation constituted one of these processes. Each of the major concepts of cognition, perception, attention, speech, problem solving, and motor ability, had to incroporate the notion that, "as higher processes take shape, the entire structure of behavior is changed" (Luria, 1979, p. 45). Of course, as Wertsch (1979, 1981) says, "both neuropsychology and psychophysiology must confront the problem of the transaction from the extracerebral to the intracerebral sphere" (p. 69).

In summing up, we might pose Vygotsky's (1930/1978b) initial research questions: "Should we conceive of thought or memory as being analogous to external activity? Do the means of activity simply play the indefinite role of supporting the psychological processes that lean on them? What is the nature of the support? What in general does it mean to be a means of thought or memory?" (p. 53). The foregoing background and studies convey some idea as to what Vygotsky intends by the

process of internalization (the process of forming the "inner plane" from the "outer plane"), but there are no real answers as yet to these questions. Yet, it might be said that individuals do remember with the aid of signs, and the development of these signs conveys some notion as to the nature of internalization. We can conclude this section by using Vygotsky's (1930/1978c) pertinent example:

> When a human being ties a knot in her handkerchief as a reminder, she is, in essence, constructing the process of memorizing by forcing an external object to remind her of something; she transforms remembering into an external activity. . . .It has been remarked that the very essence of civilization consists of purposely building monuments so as not to forget. (p. 51)

A Review of American Research

In this section, the focus will be directed toward the development of external retrieval strategies in terms of the variables of memory, attention, organization, external reward, and the theoretical models underlying these processes. Thus, an attempt will be made to summarize the American literature on cognitive, developmental processes as it relates to the issue of internalization.

Memory Studies: A General Overview

In terms of research in a broad sense, memory can be conceptualized as a composite of varied cognitive activities such as classifying, rehearsing, labeling, visual imagery and sentence elaboration in contrast to the Soviet perspective where the development of memory abilities is viewed as a consequence of social interactions and thereby dependent upon the particular socio-historical situation within which these inter-

actions occur (Meacham, 1972). The American methodologies used to study memory in children have been almost exclusively based upon experimental and cross-sectional group data rather than longitudinal studies of individuals. Response measures have been quantitative in nature, although occasionally qualitative aspects of the data also have been considered (Todd & Perlmutter, 1980).

Overall, the results of these experimental studies have indicated that young children can encode large amounts of stimulus information (Daehler & Bukatko, 1977; Perlmutter & Myers, 1974), although they process more slowly (Morrison, Holmes, & Haith, 1974; Sheingold, 1973) and are hampered by inefficient attention and search interference (Perlmutter, Hazen, Mitchell, Grady, Cavanaugh, & Flook, 1981; Vliestra, 1978). A few studies have been concerned with retention of information over somewhat longer time intervals and these results suggest that developmental changes in this activity are accounted for by changes in retrieval skills (Brown & Campione, 1972; Daehler & Bukatko, 1977). Very young children apparently have great difficulty in retrieving information upon demand and do not purposefully make efficient use of semantic information for retrieval (Perlmutter & Myers, 1979; Sophian & Hagen, 1978). Further, there is scant evidence that preschool children utilize rehearsal as a strategy (Perlmutter & Myers, 1979) and the retrieval strategies they do use appear quite ineffective (Alton & Weil, 1977; Ceci & Howe, 1978). Thus, young children's memory has been characterized as automatic, knowledge dependent, nonstrategic (Myers & Perlmutter, 1978) and involuntary (Smirnov, 1966/1973); and developmental improvements in memory performance have been attributed to the acquisition of voluntary mnemonic strategies. But, recent research indicates

that memory improvements in the early years are not necessarily attributable to increasing strategy utilization, but rather to changes in the type of processing done by children (Myers & Perlmutter, 1978). Results of these studies transmit some idea as to the substantial memory development over the early years, but essentially very little information as to the underlying factors of that development.

In sum, then, the young child's memory is directed by his/her fund of world knowledge and natural activities. After 5 to 6 years, actions can be used deliberately/voluntarily as memory strategies with social prompts. Finally, there is a significant increase in the store, awareness and spontaneous use of strategies between the ages of 5 and 12 years (Paris & Lindauer, 1982).

Now, let us turn to some of the theoretical models that underlie memory research, and then turn our attention to more specific research concerning memory, that is, memory and the use of strategies in the context of development.

Theoretical Models Underlying Memory Processes

The purpose of this section is to present four different models which appear to have the most impact upon, and provide frameworks for, the interpretation of cognitive development. At the present time there is no one theory of memory that is entirely satisfactory. The information processing, levels of processing and Piagetian points of view are summarized with their implications for internalization/development.

Information processing models. Information processing models conceive of adult memory as the transfer of information within a cognitive

construct; that is, memory processing involves the acquisition, storage and the retrieval of information. Further, the information processing view of human memory states that information storage in the brain involves sequential processes and that there is a short-term memory which can become a permanent memory (Gazzaniga, Steen, & Volpe, 1979). We shall focus upon a particular model in the information processing framework, the Atkinson-Shiffrin (1968) model, since their modified view is especially pertinent to the present study in that it considers the control processes or strategies. To utilize the Atkinson-Shiffrin model the child's memory system would be discussed in terms of capacity, encoding mode, forgetting characteristics and control processes or strategies for conveying information between the storage systems (Atkinson & Shiffrin, 1968). Thus, according to the information processing view of memory, the differences are quantitative, not qualitative. According to Matlin's (1983) description, as knowledge is acquired, new and old knowledge are synthesized into a chunk, so that each chunk essentially holds more information. Hence, in terms of development the capacity of short-term memory becomes greater, in both the size and number of chunks. In addition to the structural aspects of this viewpoint, an important factor is the control processes, which are strategies that people learn to utilize flexibly and voluntarily. Strategies are important for conveying information to long-term memory.

Another variation of the information-processing model is one put forth by Hasher and Zacks (1979). Their model essentially rests

on two basic assumptions. The first is that there is a continuum of attentional requirements among encoding processes, with the processes at either end of the continuum being labeled as "automatic" and "effortful." Effortful processes are those which include rehearsal and elaborative mnemonic activities which require considerable capacity and thus will interfere with other cognitive activities also requiring capacity. They are voluntary, show benefit from practice and change over time. In contrast, there are the automatic processes, which are involuntary and do not benefit from practice. Certain automatic processes are genetically determined, such as spatial, temporal and frequency-of-occurrence information (Hasher & Zacks, 1979).

The second assumption is that attentional capacity varies within and among individuals; variation in attentional capacity should have major effects on the efficiency with which effortful processes occur (Hasher & Zacks, 1979). Their research suggests that the relatively poor performance in memory tasks shown by the young (Brown, 1975; Flavell, 1977) and the elderly (Botwinick, 1973) could be attributed to the inefficient use of effortful learning processes.

Levels-of-processing approach. Craik and his colleagues (Craik, 1973; Craik & Jacoby, 1975; Craik & Lockhart, 1972; Craik & Tulving, 1975; Lockhart, Craik, & Jacoby, 1976) focused upon the processing or interpretation of incoming stimulus information with reference to the contents. With respect to this model, processing is considered to include a series of analyses, beginning with "shallow" sensory

processing and progressing to "deeper" abstract and semantic levels. Craik and Lockhart (1972) conceived of the memory system in terms of the processes that are carried out on material that is to be remembered and de-emphasized the structures of the system. Thus, in their model, control processes are emphasized as well as the flexibility that humans can utilize in processing information. Memory in this system is thought to be a function of the depth or level of meaning to which incoming information is processed and can be seen as the by-product of depth-of-processing. In this respect, the levels-of-processing framework concurs with the Soviet view of memory which emphasizes remembering as a consequence of meaningful interaction with stimulus material.

Piagetian model. Piaget and Inhelder (1973) proposed that memory should not be regarded as a separate cognitive capacity, but rather that it should be a function of intelligence. In Piaget and Inhelder's (1973) words: "It follows that the memory in the strict sense is part of a general set of cognitive functions, of which the intelligence represents a higher and balanced form, and that the conservation of memories rests on special but related schematizations in certain areas, but participates directly in that of the intelligence in others" (p. 390). Since Piaget's main focus was on the development of intelligence, his work necessarily led him to concentrate on the developmental changes in the context of memory rather than on explicit models of recall and recognition. However, Piaget does draw some distinction between recall and recognition aspects of memory. According to Piaget

(1968), "recognition can rely on perception and sensorimotor schemes alone, while evocation requires mental imagery or language, that is, some form of symbolic function" (p. 11). Thus, developmentally speaking the young infant (i.e., before one year of age) would not be expected to exhibit recall, but would only be capable of recognition. Perlmutter and Lange (1978) indicate that perceptual schemata constitute the instruments of recognition, whereas internalized images appear to be instruments of recall.

Implications for development/internalization. These models, then, seem to convey differences, but at the same time can be considered complementary to one another. Although Piaget's model appears to be the one stressing developmental changes, the others could also be considered in relation to age changes. If memory processes are analyzed according to the information-processing model, the major changes could be viewed in terms of control processes; thus, the children would be seen to differ in terms of the strategies they use to control the flow of information among the component parts of the system (Naus, Ornstein, & Hoving, 1978). By the age of 12 or 13 years, children could be viewed as possessing a working, flexible store of strategies (Ornstein & Naus, 1978). While, according to the levels-of-processing model (from a developmental perspective), the increased depth of information processing could be associated with memory improvement over time. Since the level-of-processing model focuses upon the critical issue of the interpretation of incoming information as related to the person's semantic knowledge, it would seem that this model is then open to handling both controlled (i.e., "deliberate") and automatic processes. Of course, if we assume this, then the implication here is that a child's existing

semantic knowledge determines what is to be remembered (Naus, Ornstein, & Hoving, 1978). This position is significant in that developmental researchers have pointed out the implications for how and what information can be remembered (see Chi, 1976; Piaget & Inhelder, 1973). A recent study by Peterson (1977) revealed age changes in recognition following an orienting task in which subjects were required to make judgements about whether stimulus photographs depicted objects that were or were not alive or in movement. On the other hand, Peterson found no age changes in memory performance when judgements were required concerning whether the objects were in color or black and white. Such results as these could be interpreted by the depth-of-processing model, since it analyzes incoming information with respect to the current knowledge fund, while the information processing models would focus upon the flow of information determined by processes in the short-term memory store.

Although the depth-of-processing model considers memory development from the point of view of the individual's changing fund of knowledge and might seem to be more adequate than the information-processing framework, it should be recognized that there are limitations of both kinds of models for memory processes in terms of such developmental questions as (1) how is new information integrated with the already stored contents of the system? (Naus & Halasz, 1978; Nelson & Brown, 1978); and (2) why can't a child utilize knowledge spontaneously when that knowledge is available? (Naus, Ornstein, & Hoving, 1978). It would seem that a first step in moving toward a developmental model of cognitive processing would be to organize programs that would simulate these information-processing systems, and a second step toward a developmental theory would be to explain how a child can move from the simple systems to the more advanced systems of performing a given task (Simon, 1979).

In sum, from a brief overview of these models, we find that a satisfactory developmental model of memory has not yet evolved, but aside from their weaknesses, the models do act as external memory aids. Gazzaniga, Steen and Volpe (1978) summarize the status of the field when they declare that the task of delineating memory processes seems more complex than ever, in that analyses "may involve uncovering the complete cerebral processing system with which humans deal with the environment" (p. 320). This opinion is shared by the Soviet view as well as by Paris (1978a) who has suggested that the task confronting developmental psychologists is to analyze both the external and internal changes in studies of remembering, particularly in terms of specifying the changes in the child and the environment that develop the subordination of actions into memory processes. What the Soviet, Piagetian and information-processing models do share is the similar view that what develops over time is a self-controlled system of operational strategies. Tulving and Madigan (1970) put forth one suggestion as to future studies in memory: "Why not start looking for ways of experimentally studying, and incorporating into theories and models of memory, one of the truly unique characteristics of human memory: its knowledge of its own knowledge" (p. 477).

Kail and Hagen (1982) argue that the developmental literature is in need of research in which multiple models of processes are precisely delineated. According to Kail and Hagen (1982) the changes observed in infancy and early childhood probably cannot be attributed to control processes, but possibly to changes in the structure, to which Piaget would agree. At the preschool period it could be postulated that the changes in memory, and the changes found during the grade school years mesh well with the pronounced appearance of control processes (e.g., strategies) as indicated by Atkinson and Shiffrin (1968) and Hasher and Zacks (1979).

Memory Strategy Studies

In this section we shall focus upon the studies concerned with the development of specific strategies, namely those external strategies that are "internalized," complying with the Soviet perspective that "the very essence of human memory consists of the fact that human beings actively remember with the help of signs" (Vygotsky, 1930/1978c, p. 51). According to Vygotsky (1929) "the child is able to acquire cultural methods of remembering such as tying knots in string or tearing bits of paper. This external activity subsequently can become internal activity" (p. 423). The internalization of so-called tools of the culture is probably similar to what Atkinson and Shiffrin (1968) had in mind when they coined the term control processes and indicated that these are the strategies that people learn to use flexibly and voluntarily and develop over time. More general literature reviews on children's development and use of strategies can be found in Brown (1975, 1978), Hagen, Jongeward and Kail (1975) and Kail (1979b).

The strategies in question involve the large and diverse range of conscious activities a person may choose as the means to remember an activity. Flavell (1977) mentioned examples of external strategies as verbally rehearsing a telephone number while waiting to use the phone, taking lecture notes, underlining key expressions in a textbook, noting an appointment on the calendar. Flavell (1977) tended to favor the use of external memory aids over unaided internal memory. He indicated that children tend to think that written notes and other people are useful aids. Vygotsky (1929) viewed auxiliary stimuli as quite diverse, ranging from tools of the culture into which the child is born to the language used in interaction with the child as well as those

means produced by the child himself.

From a developmental standpoint, the most researched and striking characteristic of the young child's memory performance is the failure to initiate and utilize memory strategies in a spontaneous manner in order to enhance encoding and retrieval information (Paris, 1978b). Nevertheless, those memory skills requiring "deliberate strategies" such as the use of external aids and organization are the very ones that produce the most profound changes during the grade school years (Brown, 1975). Luria (1973) has indicated that children at about the age of 9 or 10 years begin creating and using reminders to aid memory. Meacham and Dumitru (1976) have found that 5-year olds do not take advantage of external retrieval cues to facilitate their prospective remembering, whereas older children are able to choose an appropriate cue for further action. Several studies have shown that providing children with external memory aids, such as visible records of past solution attempts, may facilitate solution of problems (e.g., Eimas, 1970; Roodin & Gruen, 1970; Sieber, Kameya, & Paulson, 1970). One important characteristic of an adult who is attempting to recall is that he will often direct his memory search by restricting the range of responses. In this regard, he uses internal as well as external cues that are likely to remind him of pertinent information (Kobasigawa, 1977).

In general, research has revealed significant developmental changes in children's memory strategies when (1) the information is new or unfamiliar, (2) the task involves intentional memorization as the goal, (3) encoding and retrieval strategies are required to organize the information, (4) modification of study or recall behavior

is necessitated by changing task demands (Flavell, 1977; Morrison, Holmes, & Haith, 1974). In brief, a limited performance is expected of young children in tasks whenever self-guided strategies, plans and reflection might be utilized to facilitate behavior as an aid to memory. Myers and Perlmutter (1978) concluded from their study of memory development in the age range of 2 to 5 years:

> There was little evidence of planful, deliberate strategic deployment of memory processes or age-related increase in strategic utilization in the age range studied. Probably as the naturalistic memory demands on the child become more extensive he develops deliberate, then planful ways that permit him to control and utilize the full gamut of memory operations potentially available. (p. 215)

Now, let us turn to some specific studies illustrating the characteristics and development of the use of external strategies. There is a critical question of why young children, who appear capable of using strategies when offered them, fail to come up with strategies on their own. Mischel (1974) and Mischel and Patterson (1978) in their experiments found that some young children do spontaneously come up with a variety of strategies, but most fail. Kail (1979b) offers the explanation that individual differences in memory may reflect a general strategic factor; that is, some children may use strategies consistently and activate them well, and hence remember accurately; other children of the same age may utilize strategies inefficiently or not at all and thus remember inaccurately. Another reason for children's failures may be that they are not aware that any one particular strategy would be more effective than another (Yates & Mischel, 1979). A study by Ritter, Kaprove, Fitch and Flavell (1973) is pertinent. In this experiment it was shown that 3½-year old children could utilize visible external picture cues for the purpose of retrieval when explicitly in-

structed to "do anything you want to help" (p. 315). This question of the use of strategies was explored with 3½- to 5½-year old children in an experiment which involved six pictures of different persons (e.g., football player) and six small toys (e.g., football); thus, each of the pictures of a person was associated with a toy. After the child had matched the six objects with the six persons, the experimenter placed one set of the pictures face down on the floor and removed all of the toys and left the set of pictures on the floor. The child was asked to remember the names of the toys just taken from the room. The pictures on the floor could be utilized as retrieval cues for the recall of the names of the toys. Results indicated that approximately 75% of the older children (4½ to 5½ years) used the retrieval aids under prompt conditions. Additionally, 30% of the younger children did not use the cues after a demonstration. It appears that some preschool children can benefit from using external objects as cues for recall in a simple recall situation.

Kobasigawa (1974) conducted a similar study in which three experimental groups of 6-, 8-, and 11-year old children were shown 24 pictorial items representing 8 categories. In contrast to the Ritter et al. study, explicit instructions were given to one group during the presentation that indicated the relationships between the cue and each of the three items; for example, a child might see a bear, a lion, and a monkey together with the retrieval clue of a picture of a zoo. One group of children were asked to recall the names with no cues; their recall was low. The other group of subjects were given cue cards and were asked to name the items that had been associated with each card; children's recall at all ages were accurate. A third group were given

the cue cards, face down, and instructed to use the cards if they thought they would be helpful. The results for this group indicated that the younger children (first graders) rarely spontaneously used the cue cards, and when they did, they generally recalled only one item for each card. The oldest children (sixth graders) put the cards to good use and increased their recall with twice as much accuracy as the youngest children. In sum, all the children, regardless of age, seemed to benefit from the retrieval cues when required to use them. However, only the older children used the retrieval cues spontaneously. Kobasigawa (1974) analyzed the cue task in the following manner:

> A successful performance (high recall score) under the cue condition depends on S's ability to integrate spontaneously at least the following three task components: (1) to recall the small blue picture; (2) by looking at the cue; and (3) to continue the procedure until all or most of the items related to that cue have been retrieved ....(p. 132)

Scribner and Cole (1972) conducted a study in which cued and constrained conditions were involved in free recall with 5-year old children. In terms of the cued condition, subjects could recall the items in any order they desired, but the organized nature of the lists was identified and subjects were instructed that they would remember more if they recalled items from the same category together. Results indicated that cueing instructions had no effect upon the performance of the preschoolers; however, constrained recall instructions led to enhanced recall and category clustering. Scribner and Cole (1972) explained that the better performance under constrained (relative to cued) recall instructions was due to the use of more efficient retrieval strategies, although it is to be recognized that constrained recall may have influenced the manner in which children organized or

encoded the list, and they also suggested that the inferior performance of the cued groups may be attributed to the child's inability to determine the functional significance of the cues during recall.

Research by Williams and Goulet (1975) improved upon the preceding study by employing a control group (i.e., no instructions) in addition to the cued and constrained groups under free recall with preschool children. Their results suggested that the poor recall in young children may be due not to a failure to detect the categorized nature of the list but rather to an inability to utilize the cueing information in order to generate an effective memory strategy.

Another experiment revealed the most intriguing finding that cueing on recall from categorized word lists seemed to facilitate the recall performance of the 5-year olds more than 8-year olds (Eysenck & Baron, 1973). They explain their results in terms of the retrieval deficit hypothesis which suggests that the low levels of recall evidenced in young children could be attributed, in part, to difficulties in retrieval rather than that of strategy alone.

Research with internalization of external cues in related areas such as delay of gratification and self-control strategies indicates that providing a cue as to when to produce a verbal response will increase the efficiency in verbalization. In a study by Carter, Patterson and Quasebarth (1979) it was found that when preschoolers were given a temptation-inhibiting verbalization, those given either an external cue ("When Mr. Clown box tries to distract you") or an internal cue ("When you think to look at Mr. Clown box") as to when to make the verbal response, displayed greater self-control than children given the verbalization, without such cues. Thus, as children develop,

they become more capable of employing plans to regulate their behavior. However, both the cues utilized in this study would be considered external cues by Vygotsky.

In another study, Mischel, Mischel and Hood (1978) asked children whether they would find it easier to wait if the rewards were covered or if they were left in the child's view during the delay interval, and whether they thought about the consummatory or nonconsummatory aspects of the reward. The results indicated that preschool children did not appear to think about the advantages of covering the reward and of thinking about the nonconsummatory aspects of the reward; their choices were essentially random. In contrast, the third graders, and especially sixth graders, gave many more correct replies than would be expected by chance. This experiment suggests that the young child's failure to employ effective strategies may be due to the fact that the young child may not be able to delineate effective from ineffective strategies even when the experimenter asked the subject to do so.

In terms of self-control strategies as applied to natural settings such as a school situation, we can turn to a study by Sagotsky, Patterson and Lepper (1978). These researchers studied elementary school children's self-control as related to an individualized, self-paced mathematics program where the children were asked to use a simple self-control strategy, that is, these children were to self-monitor their behavior by recording instances of off-task behavior (e.g., talking, playing around) during the mathematics period and to use each recorded instance as a cue to return to work. Results showed that the children using the self-monitoring strategy had greater increases both in study time and in academic achievement than those children who util-

ized no strategy or were asked to set appropriate study goals for themselves.

What is intriguing about the successes of children mentioned in the few studies regarding self-control is that they conform to Vygotsky's concept of internalization; namely that the successes were attained not by changing the physical aspects of the world but by manipulating it in thought. Thus, the key to enhanced durability and internalization of many strategies is awareness of the strategy's benefits and not just awareness of the technique's existence. Borkowski, Levers and Gruenfelder (1976) demonstrated that children 4 to 7 years of age were most likely to learn and generalize a strategy after viewing a successful demonstration.

In terms of cross-cultural studies, Cole and Scribner (1977) note that uneducated people from non-Western cultures rely on external or culturally specific memory aids (e.g., poems, songs, knot-tying, carved sticks) and do not benefit from training on internal memory skills. Cole and Scribner (1977) indicate that the reason for these production deficiencies in other cultures is the unnaturalness of the tasks and strategies, where the value of the strategy is not apparent and where the goal of remembering for its own sake is unfamiliar.

In sum, then, preschool children's memory is usually guided by their world knowledge and natural activities. After 5 to 6 years of age, actions can be employed deliberately as memory strategies with social prompting. Yet practice, schooling and training may be required for the internalization of sophisticated mnemonic techniques. A dramatic increase in children's repertoires of available strategies, awareness and spontaneous access to skills occurs from 5 to 12 years

of age (Paris & Lindauer, 1982).

Research described so far indicates a consistent developmental progression (Flavell, 1977; Kail, 1979a), which is in line with what Vygotsky (1929/1979) and Leont'ev (1932) describe in terms of the stages of internalization. Kail (1979a) specifies the development levels as follows: "(1) infrequent use of strategies among 6-year olds; (2) a transitional stage from 6 to 9 years; and (3) reasonably mature, sophisticated uses of strategies beginning at about 10 years" (p. 32).

In sum, the young child appears quite inadequate with respect to memorization; however, research findings suggest that young children might be trained to use strategies effectively. The question remains as to why young children do not utilize cues spontaneously to aid retrieval. Another question may be raised: To what extent do our conscious intentions and strategies control the way information is processed in our minds? One is not always able to adapt thought processes to the strategies required by the task. Anderson and Bower (1973) point out that a "strategy-free system must be coupled with other strategy-dependent systems" (p. 55). A detailed analysis of the development of the young child's strategic talents is in order for future research (Brown & Deloache, 1978; Kail, 1979b).

In the kind of study with which we are concerned, the task consists of the child's ability to utilize a given mnemonic strategy to facilitate retention (e.g., retrieval, encoding or future retrieval). When the child is aware of the means, the goals, and the relationships between behavior and memory, he has attained intentional memory. Events can, then, be encoded or retrieved from memory by virtue of the child's automatic comprehension processes, and memory that results from

these situations may be interpreted according to the quality of processing analysis performed on the event (Craik & Lockhart, 1972) rather than by reference to mnemonic strategies.

Paris (1978a) discusses the difference between deliberate and spontaneous aspects of memory or what the distinction may be between self-generated and externally imposed means and goals in children. He points out that the child's ability to adopt someone else's means and goals for remembering may tell us something about children's limitations in learning or efficiency in skill usage, but it may not tell us much about how children ordinarily select ways of operating upon information to gain their own goals or how they ordinarily select their own goals. He advises that further research regarding developmental memory should be expanded to investigate age-related changes in perceived means and goals so that children's abilities to coordinate their own means with their own goals can be evaluated. In this way, the necessary and automatic prerequisites of remembering can be assessed as well as the sufficiency of externally provided means. We need to determine when children can vary their behavior systematically as the task parameters change (e.g., less time, more time, more items, feedback, larger payoffs, different purposes). The manipulation of conditions that elicit different means and goals by the child in the face of changing task demands may illuminate how children modify their behavior to achieve efficient memory.

Another direction for research may be to identify motivational changes in children's remembering. How do children regard the task, situation, and mnemonic skills presented to them or generated by them? What are the conditions that determine means-goals relationships?

Attention Strategy Studies

A similar developmental pattern is observed in the area of attentional strategies as in the section concerned with memory strategies. That is, selective attention could be characterized as shifting from external stimuli to internally regulated logical search behavior which includes the control of the strategies utilized (Wright & Vliestra, 1975). Attention, of course, looms as an important variable in the development of memory since it is an integral part of learning. "Attention can hardly be called a faculty of the mind. It is rather a condition of intellectual operations. Clear thoughts, distinct feelings, deliberate volitions are impossible without attention" (Dexter & Garlick, 1902, p. 29). Vygotsky (1929/1979, 1981) writes: "The history of attention in the child is the history of the levels of the organization of his/her behavior" (p. 191).

Research on the development of attention concludes that older children are more flexible and systematic than younger children with respect to the particular demands of each task. As to specific research Hagen and Hale (1973), Pick and Frankel (1973) find that when a task calls for attending to relevant material and disregarding irrelevant material, selective attention increases with age. Developmentally, Hagen and Hale (1973) summarize the research by indicating that, in general, the recall of the central stimuli increases through the elementary and high school periods, while at the same time, recall of the incidental stimuli stays about the same or increases a little up until ages 11-12 and then shows a decrease. How is this apparent lack of selection in terms of attention explained? According to Kahneman

(1973) and Navon and Gopher (1979) developmental differences in attention could result from a tendency by young children to direct a portion of their attentional capacity to the processing of irrelevant information. Thus, this theoretical position assumes that one has a limited amount of capacity that one can distribute among stimuli flexibly and deliberately. Lane and Pearson (1982) suggest that one reason children's attentional processes may be somewhat less flexible than that of adults is that the children tend to direct proportionately more attention to the irrelevant stimuli at the expense of relevant stimuli. Another reason advanced for differences in the child's and adult's attentional capacity is that children have more difficulty inhibiting responses to the irrelevant stimuli than do adults (Lane & Pearson, 1982). Eriksen and Eriksen (1974) and Stroop (1935) have hypothesized that interference based on the presence of irrelevant stimuli can occur due to response competition rather than to capacity limitation. This position has some semblance to what Pavlov (1928) said many years ago about the process of external inhibition:

> External inhibition is a complete analogue of that inhibition which was recognised long ago in the lower parts of the central nervous system when a newly arriving reflex inhibits one already present and active. It is evidently the expression of a ceaseless conflict among the different sorts of external and internal stimulations which determine which shall become at the given moment of predominant significance for the organism. (p. 244)

Hasher and Zacks (1979) have further clarified these foregoing suppositions with their framework of effortful versus automatic processes which yielded findings that variation in attentional capacity did effect the efficiency with which effortful processes occur, but in contrast, automatic processes did not show similar effects because of their minimal

drain on attentional capacity. Hence, the act of maintaining attention for a task requires effort, which suggests that on-task attention can reduce the probability that other stimuli will interfere (Posner & Snyder, 1975). Posner and Snyder (1975), thus, believe that the main importance of a strategy which directs attention to an input channel or memory pathway is not merely to facilitate the selected item (benefit) but mainly to reduce the chance of interference from the external environment (cost); thus, the strategy constitutes a trade-off in terms of the distribution of attentional efforts.

In general, then, the younger child may find it difficult or impossible to engage in specific types of mental processes (e.g., the effective use of strategies) or acquire concepts of a specific level of complexity due to the fact that his current attentional or short-term memory capacity is not developed (Flavell, 1982). It is postulated that as he grows older, this capacity will gradually increase, and the increase will in turn make possible new and higher levels of cognition and knowledge. At this point in time there is considerable controversy as to the exact nature of the child's capacity limitations. Exactly how much the child's processing capacity limitations actually restrict the range of problems with which the child may deal is an unresolved question.

With this background in mind, let us turn to some specific studies dealing with attentional strategies which may demonstrate the role of external signs in attention and memory. There are, of course, far more studies of children's attention than can possibly be reviewed here. Rather than presenting a comprehensive review of memory and attention, the pertinent research on the question of how attention re-

lates to the use of the internalization of strategies within a developmental context will be provided. Most of the studies in this area utilize the incidental-central paradigm. (For example, the experiment involves introducing irrelevant stimuli into a task and then observing how well the subject attends to the central task in the presence of possible distractors, i.e., incidental stimuli). The classical study in this area is one by Hagen (1967) whose research with children 6 to 13 years of age indicated that the first improvement in memory occurs partly because of the child's increasing ability to attend to specific cues and to ignore others. This general finding was supported by the result that central memory scores correlated positively with incidental memory scores at the younger ages, but negatively at the older ages, lending credence to the fact that older children tend to be more efficient than younger children at selectively attending to the central variables and excluding the irrelevant information.

In two memory studies (Hagen & Frisch, 1968; Maccoby & Hagen, 1965) where a distractor task had been employed with children, a detrimental effect on central task performance was found, but this effect was not found in a study with adult subjects (Hagen, Meacham, & Mesibov, 1970). Thus, adults' memory performances appeared to be relatively unaffected by the presence of incidental stimuli (Hagen et al., 1970). It appeared that imposed irrelevant stimuli, such as piano notes or pictures, interfere with the performance of the younger, but not the older, individuals. An explanation advanced was that the younger child appeared to be dependent upon immediate stimuli in the environment, possibly because he did not yet have well-developed strategies for dealing with the specific task at hand. The older subject

apparently possesses these strategies and can filter out the imposed irrelevant stimuli, unless they interfere directly with the utilization of strategies.

A more recent study of selective attention by Miller and Weiss (1981), where the incidental learning paradigm was utilized for children from grades 2, 5, and 8, indicated that the greatest increase in selective attention came between grades 2 and 5. In contrast, the greatest improvement in performance for the incidental learning task occurred for grades 5 and 8. Strategies of attention and performance on the learning task were not significantly related. These results support the finding that there are developmental changes in selective attention or efficient performance on the incidental learning task. The authors interpret the differential results in terms of age to mean that possibly second graders do not understand the goal of the task since they remembered only one of two sets of drawings. Another explanation was the possibility that second graders actually realize the value of gathering relevant information, but have specific characteristics which limit them in demonstrating their knowledge. In regard to the finding of a lack of a direct relation between strategies of attention and performance on the incidental learning task, explanations are offered in terms of competing responses and metacognitive deficiencies. Thus, this study points out the fact that there are factors in addition to selectivity of attention that must be considered in the research of attentional strategies. For example, Hale (1979) indicates that there are developmental changes in the dispositions to pick up more useful information from stimulus components and to assimilate attention into the task requirements.

Older children are found to regulate their strategies to the task goal more easily and quickly than young children and also understand not only how to attend selectivity but also when it is to their advantage (Hagen & Hale, 1973).

Hagen's (1972) research on selective attention indicated that there was a limited channel capacity which did not increase with age. Under overload conditions, older subjects were more efficient at directing more of their attention to the task at hand. While, of course, there is a limit to how much a child can handle, Hagen (1972) believes that it is not just because this limit is exceeded that "selective" attention occurs. Rather, external demands interact with the subject's state at the particular time, a hypothesis that fits well with the Soviet view as to what happens in the means-goal situation. That is, a particular task set is imposed by some external source (i.e., a parent, a teacher, or an experimenter); this set is received differently by children of different ages. Older children better understand the nature of the demands placed on them and also have available appropriate strategies to deal with them. As Hagen and Kail (1975) conclude, "selectivity in attention of children . . . clearly comes about through the employment of task-appropriate encoding strategies rather than through the use of increasingly finer perception discriminations of the stimuli themselves" (p. 172). Thus, selective attention is found to be one component in the strategies for facilitating memory development (Hagen & Stanovich, 1977) and is representative of the cognitive skills that underlie development during childhood. This conclusion meshes with Vygotsky's summary statement about memory: ". . . what changes is the interfunctional relations that connect memory with other functions" (1930/1978c, p. 49).

Organizational Strategies

The attention and strategy variables bring us to the ability of the child to organize (or the attempt to bring order and patterns to) these variables for use. Wertsch (1979, 1981) says that "the most important point in development is: children organize stimuli in order to achieve their response" (p. 182). Essentially, studies have shown that people tend to organize items spontaneously, even when they have not been directed to do so. Bousfield (1953) presented people with a list of 60 nouns with 15 nouns from each of 4 categories: animals, names, professions, and vegetables. The result suggested that people tended to group the words into categories to recall the words.

Some investigators have measured response times during recall as an indicator of organization. Kobasigawa and Orr (1973) recorded the time between successive recall of two items from the same category and compared it with the time between successive recall of any two items from different categories. Kindergarten children showed within-category intervals that were shorter than between-category intervals under conditions that produced a high amount of list organization, but no differences in lengths of intervals when list organization was low. Consistent with these results, Gelfand (1971) reported a relationship between response latencies and clustering scores in adults' free recall. Another study by Goldberg, Perlmutter, and Myers (1974) with 2-year olds indicated that the interval between responses was briefer when items were members of the same conceptual category than when items were unrelated. These studies give credence to the phenomenon of organization, even in very young children, although its most appropriate measurement may not be ascertained as yet. Ornstein (1972) states: "The more or-

ganized . . . the memory . . . the shorter the experience of duration" (p. 87).

Organization strategies, such as grouping and categorization, are frequently used by adults, as we saw above. However, young children do not tend to group similar elements together to aid memory. Moely (1977) designated the following developmental features as to how younger children differ from older children: (1) younger children have a tendency to process the meaningful features of items; (2) they base their grouping on the number of established concept categories in evidence; and (3) upon the nature of features used to group items. For example, a young child may respond to the shape of pictures rather than their meaning. Finally, even if children do pay attention to an item's meaning, they may group items in the same category if they go together. For example, a desk might go with a father if the father typically uses the desk.

An additional reason that young children do not use organizational strategies might possibly be attributed to the lag between the development of semantic abilities and the use of these abilities in organizational strategies. For example, in a study by Moely, Olson, Halwes, and Flavell (1969) where children were asked to study and rearrange pictures from four categories (animals, clothing, furniture and vehicles), younger children seldom moved the pictures next to other similar pictures, but older children frequently organized the pictures in terms of categories. Other groups of children were specifically instructed to organize the pictures. Thus, the training enhanced organizational strategies and hence recall, even in the younger children. Other researchers (e.g., Moynahan, 1973; Tenney, 1975) hypothesize that young children do not realize the value of organization as a tool for recall.

What can be said, in sum, about organizational strategies? Recent information-processing models (Klahr & Wallace, 1976), Soviet accounts (Leont'ev, 1972/1979, 1981), and mediational developmental theorists (White, 1965) have all focused upon deliberate methods of attending to information and reorganizing it into meaningful, useable units. These models suggest that with development this skill can become progressively differentiated and integrated.

In conclusion, evidence is accumulating that appears to be consistent with Leont'ev's theory of the development of internalization. For example, Kreutzer, Leonard, and Flavell (1975) found that kindergarten children were more likely to indicate that they could use external means of memorizing such as writing a telephone number, than internal means, such as rehearsing. These children also indicated a readiness to rely on other people to facilitate their own remembering. Flavell (1977) reported that older children are more likely than younger children to use internal rather than external means.

Harris (1982) in his research with internal and external aids suggested that external aids are more dependable than internal ones for both older and younger subjects, but little is known as to the use of internal aids versus external aids in practical, everyday life situations. How do external aids become internal aids? Analyses of both external and internal changes seen while observing children's remembering will allow us to determine developmental changes in the process of internalization. In spite of the differing research methodologies and variables studied, we find that the one common thread that weaves consistently throughout this section on memory strategies is that memory is dependent not only on other cognitive variables such as attention

and organization, but on environmental/cultural variables as well.

The Role of Reward

"Motivation is not only a function of the perceived probability of success and incentive value of an immediate task, but also a function of the probability of success and incentives of future goals and tasks, the attainment of which are contingent upon successful completion of the immediate task" (deCharms & Muir, 1978, p. 94). In this section we shall focus briefly upon the interaction of various factors mentioned in the foregoing definition with an emphasis upon "the second series of stimuli" which might serve as the "psychological means" for this activity. In other words, we shall consider reward as an external stimulus which might be assimilated within the cognitive processes in either a negative or positive manner with special attention to developmental aspects.

The research of Harry Harlow (1950) has shown that monkeys will manipulate puzzles without any external reinforcement, until the puzzles are baited with a raisin reward. Having experienced baited puzzles, the monkeys lose interest in unbaited puzzles. This result caused deCharms (1968) to ask whether an external reinforcer, when added to an ongoing, intrinsically motivated activity, would reduce the subsequent probability of the response when rewards are no longer present below the initial unreinforced level.

Answers to this question have been reflected in recent studies. These research studies have shown that the offer of extrinsic rewards can produce adverse effects upon human motivation and performance (see deCharms & Muir, 1978; Lepper & Greene, 1978, for recent reviews).

Most of this research has been concerned with the detrimental effects of extrinsic rewards on subsequent (unrewarded) intrinsic interest in an activity (Csikszentmihalyi, 1975; Deci, 1975; Lepper, Greene, & Nisbett, 1973). However, there is a further issue of a detrimental effect of reward that is appearing currently in the literature. This is the detrimental effect of an expected reward on performance (Condry, 1977; Kruglanski, Friedman, & Zeevi, 1971; Levine & Fasnacht, 1974; McGraw, 1978).

In some of the reviews that have been concerned with the detrimental effects that extrinsic rewards have on performance and intrinsic interest, there is a suggestion that the two effects are casually related (Condry, 1977; Kruglanski, Friedman, & Zeevi, 1971) or might be related (Lepper & Greene, 1978). The strongest evidence for this relationship has been put forth by the research of Kruglanski et al. (1971), showing that the offer of an extrinsic incentive produced performance declines on tests of verbal creativity and then showed that intrinsic interest as measured by questionnaires, was also lower among the subjects who had been offered an extrinsic incentive. The explanation advanced for the performance-interest relation was that intrinsic-extrinsic interest differences between groups were present at the time of task engagement and that the more intrinsically oriented subjects did better at the cost of verbal creativity, because "intrinsically motivated individuals . . . exhibit superiority on those aspects of performance contingent upon preoccupation with the task, as opposed to concentration upon attaining the goals" (p. 607).

Deci (1975) postulated that if an extrinsic reinforcer is perceived as controlling behavior, the person's intrinsic motivation for

a task will be reduced. Informational reinforcers will not be seen as externally controlling. Deci demonstrated that tangible positive reward (money) reduced initially intrinsically motivated behavior with college students on both laboratory and more natural settings.

Kruglanski, Riter, Amitai, Margolin, Shabtai, and Zaksh (1975) measured rated task interest, rated task preference, and task resumption. Where money was inherent to the activity (stock market games) payment increased intrinsic motivation. When task activity was only instrumental to gaining money, payment decreased intrinsic motivation.

Calder and Staw (1975) hypothesized that intrinsic motivation is undermined by extrinsic rewards only when the task is intrinsically interesting to begin with. They manipulated both intrinsic (dull vs. interesting tasks) and extrinsic (payment vs. nonpayment) factors and measured task satisfaction. Findings indicated that extrinsic rewards increase intrinsic motivation in the face of a dull task.

Riess and Sushinsky (1975) proposed that a salient reward "can elicit many responses that interfere with play" during the reward period and that subsequently "children will be less interested in play activities to the extent that responses are elicited that interfere with play behavior prior to" the discontinuance of the reward (p. 1118).

Viesti (1971) focused upon the effect of monetary rewards on an insight learning task. Results indicated that performance on insight tasks was not affected by external contingneices.

In a series of studies with preschoolers, Lepper and Greene (1973) have shown how doling out rewards can have negative effects. In one

study (Lepper & Greene, 1975) the first group of children were rewarded for working on several puzzles, and the second group of children received no reward for manipulating the same puzzles. Later, when all the children were free to play with puzzles or not, as they chose, those children who had come to expect a reward for their efforts spent only half as much time with the puzzles as did the others who had been self-motivated from the beginning. Lepper and Greene interpreted their findings to mean that play had been transformed into work for the children as a result of the rewards.

One recent study (Reed, Cogan, & Landers, 1981) with 5- and 6-year old boys and girls used the manipulation of flavor as a reinforcement predicting cue to separate motivational and cue properties of incentive. The results showed that the presence of the reinforcement predicting cue resulted in interference when it contributed reward-relevant but solution-irrelevant information. Learning was facilitated when the reinforcement predicting cue contributed useful information in complex discrimination tasks.

Another study (Sarafino & Stinger, 1981) rewarded one group of kindergarteners and fourth graders with a nickel and another group with praise for giving "funny endings" to riddles. The results showed that reward increased the number of endings the children gave. However, fourth graders who received praise took more riddles home than those who received money. Thus, presenting a "prize" or money to children and adults can change task performance, but reward has been found not to change that behavior in a predictable manner.

In terms of studies specifically concerned with the effect of reward upon memory, the following studies might be mentioned. For ex-

ample, Thorndike and Forlano (1933) conducted experiments where boys (10-16 years) were given increasing monetary rewards for selecting an increasing number of correct answers from a group of multiple-choice questions. Results indicated that an increase of the reward for a correct answer increased learning but, afterward, even had a negative effect. Other studies (Russel and Farber, 1948; Sears, 1937) have investigated failure upon memory. Russel and Farber's (1948) study involved a memory task when the subjects who had failed in reproduction immediately after memorization showed better results one week later than the subjects who had shown good results previously. In attempts to interpret these results, McGeoch and Irion (1961) pointed out the close association between the effects of competition, success and failure, and the level of motivation in the subjects. As further explanation of the interplay of factors, Bower (1970) comments that "the important ingredient in memory appears to be the cognitive constructive activity itself, not just the motivation or reward" (p. 504). Miller, Galanter and Pribram (1960) confirm this point by saying: "It is the execution of the plan, not just the intent to execute it, that is important for the memory" (p. 130). Of course, the important ingredient for memory may well be the cognitive constructive activity itself, but it must also be remembered that the quality of this cognitive construction is subject to developmental principles, and reward may not even be a factor that can be cognitively assimilated at certain ages. For example, in a recent study regarding development of memory, Myers and Perlmutter (1978) tested recall in children. These children were shown nine unrelated common objects. After the experimenter presented each item and named it, the children were told that they could keep all

the objects that they correctly recalled. In spite of the tempting incentive, recall was poor. Myers and Perlmutter (1978) discussed many reasons for the children's superior performance on recognition tasks versus recall tasks. They explain that recall--but not recognition--may require more active rehearsal strategies and more thorough searches of memory. Thus, younger children may recall fewer items because they do not have effective memory strategies.

Diggory (1972) says that under extrinsic reward young children (preschoolers) are generally more responsive (behavior increases) to praise and attention, whereas older children may be more responsive to the intrinsic reward of being correct. Vygotsky would interpret this change in the planning and directing function (served by the reward) as the result of moving from the "interpsychological" (between people) to the "intrapsychological" (within the child) plane of functioning (1930/1978b, p. 57).

White (1970) has indicated that older children no longer require external rewards, but their reward is the information that they have been correct; they adopt an internal standard of performance. This explanation fits in with Vygtosky's tenet that cultural aspects are gradually internalized to organize cognitive processes.

Current theory and data (i.e., Deci, 1975; Kruglanski, 1975; Lepper & Greene, 1978) indicate that the capacity of extrinsic incentives to undermine intrinsic motivation may be influenced by the method of reward administration (contingent or noncontingent). A study by Fabes, Moran and McCullers (1979) suggested that the method of reward administration may not be critical to obtaining detrimental effects of a reward on immediate task performance. This result would be consistent with a statement made by Lepper and Green (1978) that immediate task

performance and intrinsic motivation, though obviously related to each other, may not be governed by precisely the same factor.

The findings of Mischel and Baker (1973) show that different modes of presenting rewards (i.e., real vs. symbolic) may either enhance or inhibit self-control and suggest that the specific ways in which rewards are construed may have crucially different effects on behavior. Mischel (1973) indicated that a stimulus may have a motivating, consummating, arousal function as an informational (cue) function. In one study (Mischel & Baker, 1973) the experimenter directed the children to think about the reward objects which confronted them in either consummatory or nonconsummatory ways during a specified delay interval. That is, in the consummatory condition, the child was asked to focus upon the most delicious qualities of the reward which faced him (e.g., chewy, sweet taste or a marshmallow). In the nonconsummatory condition, the child was told to think about rewards as inedible objects (e.g., marshmallows as puffy, white clouds). The results indicated that the children were able to wait twice as long if they mentally pictured rewards in a nonconsummatory manner, which suggests that mental representation more distant from physical reality facilitated their progress toward the goal.

In another study (Patterson & Carter, 1978), attentional determinants of preschool children's self-control were compared in two kinds of experimental situations. In one situation children waited for delayed rewards and in the other they worked for delayed rewards; both groups did so either in the presence or absence of the reward objects. Results showed that children in the waiting condition might become frustrated as they attended to the motivational properties of rewards,

but evident rewards for children in the working condition might actually tend to energize and facilitate their activity toward the goal. Thus, presence of reward objects limited self-control when it involved merely passive waiting, but when active work was called for, the rewards energized performance. These results tend to support the Soviet research of memory which contends that an important condition for involuntary memorization is action integrated with the objective of memorizing (Smirnov, 1966/1973).

Presenting a "prize" or money to children and adults can change task performance, but reward has been found not to change that behavior in a predictable manner. That is, sometimes reward facilitates performance, other times there is no change, and in still other situations the presence of reward seems to interfere with performance. How do we resolve the positive and negative findings in terms of research with intrinsic rewards?

There are several formal theoretical models that we may draw upon in the research literature to explain reward effects. One such theoretical model is the traditional Hull (1956) stimulus-response learning theory formulation, which predicts that an increase in incentive motivation causes the most readily available responses to be elicited. Responses are more readily available for simple tasks, whereas in complex tasks, the most available responses lead to errors. There are some problems with this traditional learning theory in that most of the support for this model has come from animal studies.

Another theoretical position proposed in recent years is the distraction hypothesis, espoused by Janet Spence (1970, 1971), which centers on attention and assumes that the inferior performance of the

reward group is due to distracting their attention from the task stimuli. This model presently is unable to handle the detrimental effects of a promise of reward.

Recently, McGraw (1978) has proposed a two-factor model which predicts when rewards might be expected to interfere or enhance immediate performance. The first factor, the attractive-aversive dimension, is concerned with the subject's initial perception of the degree of attractiveness of the task. Rewards appear to be detrimental when the task is initially attractive; rewards are found to be enhancing when the task is initially perceived as unattractive or boring. The second factor, the algorithmic-heuristic dimension, is concerned with the nature of the solution strategy demanded by the task. In algorithmic tasks, the subject usually can proceed toward problem solution in a direct, straightforward, almost automatic manner. In heuristic tasks, the solution is not evident; insight and discovery are usually required to discover it. McGraw's model predicts a detrimental effect of rewards on performance with attractive heuristic tasks (algorithmic-heuristic dimension), but an enhancing effect in algorithmic tasks. All combinations of aversive tasks (attractive-aversive dimension) lead to the prediction that rewards should enhance performance. This model has been tested by some research (McGraw, 1978; McGraw & McCullers, 1974; McGraw & McCullers, Note 1; Moran, 1975; Moran, McCullers, & Fabes, Note 3; Moran & McCullers, Note 2).

A fourth model for dealing with the adverse effects of rewards on performance makes use of a developmental regression (Fabes, Moran, & McCullers, 1981). The research of McCullers and his colleagues suggests

that in addition to motivation, rewards may also adversely affect cognition, attention, creativity, and the perception, organization, and integration of information. In terms of the regression model, rewards are seen to shift the subject's functioning to a more primitive developmental level. That is, the subject shifts from a predominately cognitive mode toward a more physical and emotional way of responding. This concept of regression may provide a better understanding of why rewards should facilitate performance in some situations but not in others.

A recent unpublished study (Moran, 1978) involving subjects at three age levels (5, 10 and 19 years) and matched on ability level, investigated reward effects in terms of Wechsler Intelligence Scale subtests. Nonreward subjects were administered all subtests under standardized instructions, while reward subjects were given two subtests under nonreward conditions and the remainder under reward conditions. On more algorithmic subscales, reward improved performance in high ability students at all three age levels. Average ability adults, on the other hand, performed significantly better under reward on these tasks. On heuristic tasks, reward had a detrimental effect on the performance of both high and average ability adults, had little effect on fourth graders, and facilitated the performance of the preschoolers. The data appeared to be explained most easily in terms of the developmental regression model, suggesting that reward may lead to a greater degree of diffuse responding in young children and to more rigid functioning in adults.

In view of the fact that McGraw's (1978) study revealed that reward's effect on performance varied with the cognitive requirements of

the task, it will no longer be sufficient to say that extrinsic incentives have a detrimental effect because they set off a self-attributional process that alters one's source of motivation from intrinsic to extrinsic (e.g., Kruglanski et al., 1971), or because they distract (e.g., Spence, 1970), or because they cause subjects to adopt an instrumental, goal-oriented strategy (Condry, 1977; Kruglanski, 1978; Lepper & Greene, 1978). The foregoing results will not serve as explanations since they fail to explain why self-perceptions in a task, or distraction, or goal orientation should have a detrimental effect on one type of problem but not on another. More knowledge is needed of the range of tasks over which one finds a detrimental effect of reward on performance in order to better describe the reactions of the extrinsically motivated subject.

Concluding Comment on Rewards

The brief review of these studies was not meant to suggest that external rewards, particularly monetary rewards, have no place in our society. The point here is that external rewards should be used with caution. Parents and teachers should be aware of the nature and effects of extrinsic rewards in the education and socialization of children. Locke (1693) phrased it nicely when he advised:

> Rewards, I grant, and Punishments must be proposed to children if we intend to work upon them. The Mistake, I imagine, is that those that are generally made use of, are ill chosen. The Pains and Pleasures of the Body are, I think, of ill consequence, when made the Rewards and Punishments, whereby Men would prevail on their Children: For as I said before, they serve but to increase and strengthen those Inclinations which 'tis our business to subdue and master. (p. 11)

Memory Strategy Studies in the Elderly

There is some evidence that memory strategies differ for young and old people. Why are the memory strategies of older people different from the memory strategies of younger people? Some studies have shown that memory for pictures declines faster than memory for words (Winograd & Simon, 1980), and so visual images may be more difficult for the elderly. Further, it is possible that some strategies, such as organization, are encouraged in formal education so that the elderly no longer need these active learning strategies once they have left school (Smith, 1980).

A number of studies have pointed to the fact that older subjects are less adept at using verbal and imaginal mediators to improve their memory. In one study Hulicka and Grossman (1967), using a paired-associate learning task with old and young subjects, issued no special instructions to one group and instructions to use mediators for the second group. Results for the group with no instructions indicated that the older subjects showed a lesser tendency to use the mediators spontaneously than the young; however, the older subjects did benefit from mediation instructions. Hence, the elder group were able to perform the mental operations required for the formation of a mediator, but did not typically carry out the operations. Chown (1961) has indicated that this may be due to increasing cognitive rigidity or perhaps decreased "depth of processing" (Craik & Lockhart, 1972) in the elderly.

An example of the development of memory in old age is put forth by Reese (1976). When the author's mother realized that her memory was failing, she began to use written notes as memory aids, however, her

strategy became inefficient since she wrote many of the notes in code and then forgot the code. An additional problem could arise when one forgets where one placed the notes.

This story illustrates two characteristics about memory strategies in the elderly: (1) The strategies may not have been previously experienced in earlier stages of development and (2) they may not have been utilized efficiently (Reese, 1976). Thus, the problem may be in using inefficient retrieval strategies. In the preceding example, the retrieval cue used may, like a string tied around a finger, revive only the memory that something was to be remembered, and not the content that was to be remembered, a production inefficiency. A study by Hultsch (1975) illustrated that the problem with the elderly is one of retrieval not of storage. His study examined age differences in cued and noncued recall of lists of words in young and old adults and found that both trace-dependent and cue-dependent forgetting occurred more often in the old than in young adults.

There is increasing evidence that the spontaneous unprompted use of mnemonic devices in acquisition increases with age in children (e.g., Canestrari, 1968; Hulicka & Grossman, 1967; Hulicka, Sterns, & Grossman, 1967). These studies may provide data as to an explanation for any retention deficit in either the young or the elderly if the assumption is made that mediated habits are "protected" from interfering activities, are more resistant to interference from competing habits, or are simply better learned than those acquired rotely (Kausler, 1970). This supposition is supported by Hasher and Zacks' (1979) model of effortful versus automatic processes which suggests that automatic processes occur without intention, without necessarily giving rise to awareness and

without interfering with other processes; while the effortful processes are those that are susceptible to interference and subsequently influence cognitive processes. Thus, variation in attentional capacity should have more effect upon the efficiency with which effortful processes occur than with automatic processes. Deficits in their performances should then be seen in instances of reduced cognitive capacity. On the other hand automatic processes, because of their minimal drain on capacity, should not be similarly affected by a change in cognitive capacity. Their results then suggested that, in fact, effortful processes appeared to be more susceptible to interference than the automatic processes.

The implications from the foregoing research are that susceptibility of interference has a different meaning for the young and for the elderly. For example, young children may not have acquired the higher-order rules or strategies (inhibiting skills) but such rules or strategies may actually dominate the behavior of the aged. In the young child the relative lack of inhibitory skills suggests a susceptibility to associative interference (White, 1965), while in the elderly apparent susceptibility to interference is assumed to reflect generalized (or overgeneralized) tendencies to inhibit the effect of prior learning, whether observed in the laboratory or in the natural environment (Goulet, 1973).

As in childhood, the age differences seem to reflect changes not in capacity, but rather in control operations. Unlike the child, however, the old already have the required memory processes, and if it is assumed that the age differences reflect age changes, then the old already had the required strategies in their organization. Yet, the

old exhibit production inefficiencies and deficiencies. The problem lies in how to explain these. Reese (1976) advances the explanation that these strategies have become functionally less available because of disuse. Though, once well established, they have become less well established and hence exhibit the deficiencies like any strategy that is not well established.

In general, it has been found that age differences are less evident when subjects are provided specific learning instructions (Canestrari, 1968; Hulicka & Grossman, 1967; Hultsch, 1971; Perlmutter, 1978, 1979). These findings suggest that older adults spontaneously use effective acquisition strategies less than younger adults, even though such strategies are available to them. Other characteristics of the elderly, such as time for performing, motivation and cautiousness, also should be considered in their performance in an experimental situation. Thus, when enough time for response is available, performance of older adults is only slightly worse than that of younger adults (Arenberg, 1965; Canestrari, 1963; Eisdorfer, Axelrod, & Wilkie, 1963; Monge & Hultsch, 1971; Taub, 1967). Differences in motivation have also been thought to contribute to the differences on experimental learning tasks; some researchers assume that older adults are not as motivated as younger adults, but Botwinick (1978) has indicated that older adults are more involved in experimental situations than are younger adults. Finally, in regard to cautiousness, it is thought that older adults are more cautious than younger adults. Research suggests that older adults make more errors of omission but rarely errors of incorrect responding (Eisdorfer, Axelrod, & Wilkie, 1963; Korchin & Basowitz, 1957).

In sum, then, of the elderly we find that essentially there is a

decline in the utilization of memory strategies including focused attention which could be assumed to be due to an inefficiency in control process not capacity. Reese (1976) indicates a decline would result from production deficiency or production inefficiency, increasing with age. Pavlov (1941/1963) summarized the disposition of the memory system in the elderly by stating:

> The mechanism is exactly the same, varying only in degree, arising in old age as the excitatory processes of the cortex naturally decrease. In the brain which is yet strong the external and internal stimulations concentrate to some degree (extremely only exceptionally) in a definite cortical point or region, accompanied of course by negative induction, but thanks to the strength of the cortex it is not complete and at some distance inhibition is extending. Therefore together with the chief excitation another one is acting to a certain degree to evoke the corresponding reflexes, especially the old established so-called automatic ones. Ordinarily in our behavior we react not singly, but completely, to fit the ever present contents of our environment. In old people the matter is altogether different. Concentrating on one stimulus we exclude by negative induction other collateral and simultaneous stimuli because they often do not suit the circumstances, are not complementary reactions in the given setting.
>
> Let me give a minor incident of this. I look at some object which I need, take it and do not see anything touching or near it--this is why I unnecessarily strike against surrounding objects. This is erroneously called senile distraction, on the contrary it is concentration, involuntary, passive, defective. Thus the old man, dressing and at the same time thinking about something or talking to someone, goes out without his cap, takes the wrong article, leaves his clothes unbuttoned, etc., etc. (p. 109)

Overview

Summary

We began the research by asking the general question--How is an internal process able to represent an external object? In other words, how are external strategies transformed into internal, mental actions or how do children master their environment? This issue is important since it enables the child to structure new solutions internally. Thus, as Leont'ev (1972/1979, 1981) had indicated, in the transition from external processes to internal ones, "these processes moving outward to inward, thus, constitute the process of internalization. Thus, the process of internalization is not the transferal of an external activity to a preexisting, internal plane of consciousness: it is the process in which this internal plane is formed" (p. 57).

In order to gain some insight into the internalization process, we briefly reviewed the philosophical foundations and systems to determine how they evolved into the Soviet psychology of the present. Then, we briefly reviewed Soviet and American studies in memory. We began with a consideration of memory processes, because Vygotsky (1930/1978c) indicated that it is central to the social origin of signs as well as to the development of thought processes. Since a complete review of research in memory processes would be overwhelming, we concentrated upon those components--attention, organization, and strategies--which were deemed to have the most significant relationship to memory, thought and behavior. The following is a brief synopsis of the major ideas from the Soviet and American research in these areas.

Soviet research in memory extends over an extensive range of mental variables--involuntary and voluntary memory, memory for isolated words, numbers, and objects of textual material and particularly the training/teaching of memory abilities in young children. All of these research areas are studied within the socio-historical framework which emphasizes the motivational context within which memory might occur (e.g., work or play) and analyzed in terms of means-ends relationships formulated among various operations or abilities and the action of remembering (Smirnov, 1966/1973).

Soviet results in memory research have indicated that young children's memory is involuntary--dependent upon comprehension processes which are automatically stimulated by real-world cues and experience--and nonstrategic. Memory development, then, moves from an involuntary, nonstrategic process to one that is voluntary and strategic. According to Soviet researchers (e.g., Smirnov, 1966/1973), memory development may proceed as follows: the earlier processes are built upon repetitive, social interaction, which later became nonconscious or automatic and hence allow the child to deal effectively with the subject at hand. These automatic systems may only be brought into consciousness, when perhaps deficiencies occur in their particular function (e.g., Vygotsky, 1934/1962). Let us take an example which Leont'ev (1972/1979, 1981) uses to illustrate this point: shifting gears in an automobile essentially becomes automatic, but when confronted by some failure in the shifting system, particular representations of actions and memories are brought into play and reconstruction or repair proceeds. Thus, these conscious factors permit the individual to react reflectively rather than automatically. In the words

of Vygotsky (1930/1978c): "In the elementary form something is remembered; in the higher forms humans remember something" (p. 51).

In terms of more specific components such as attention and strategies and motivation, Vygotsky states (1929/1979), "Voluntary attention begins with external phenomena, and is gradually transformed into an internal operation" (p. 77). More specifically, Vygotsky (1929/1979) advanced the following understanding of the processes of voluntary attention.

> Therefore, we can say that voluntary attention . . . is the process of mediated attention that has gone underground. The path of this process falls completely under the general law of the cultural development and formation of higher forms of behavior. This means that the content, structure and functions of voluntary attention are not simply the result of the natural, organic development of attention. Rather, they are the result of changes and reorganizations of the whole process under the influence of external stimulus-means. (pp. 82-83)

Finally, with respect to motivational factors, Soviet experiments (e.g., Smirnov, 1966/1973) indicated that a motive (e.g., praise, money) of and in itself does not determine completely either the nature of the activity or its productivity and that the degree of their influence depends on the activity which moves man to action. The same motive in different subjects can evoke entirely different responses. Smirnov and Zinchenko (1969) describe memory performance as a function of the activity of the subject rather than as a reflection of various stimulus materials and their presentation.

Smirnov and Zinchenko (1969) state that all the investigations in memory point to one and the same thing:

> . . . With age the role of the second signal system, emerging in studies on recall of verbal and abstract material, with use of verbal supports, increases, as a result of which the dif-

> ference between retention of the two types of material and between the two types of support gradually diminishes; however, even in adults visual material is remembered more efficiently than verbal-abstract material, and visual supports display a more active effect than verbal supports. The best retention is observed in the joint operation of both signal systems. (p. 484)

In sum, Soviet psychologists (e.g., Luria, 1966/1980) consider that the higher human cognitive processes (e.g., memory, attention, etc.) are complex reflex processes, social in origin, mediate in structure and conscious and voluntary in type of function.

American researchers have come to conclusions similar to the Soviet results. In general, findings have indicated that older children are more likely than younger children to employ appropriate memory strategies. However, young children are able to use their strategies when the experimenter provides assistance. Thus, young children appear to have what is called a "production" rather than a mediation deficiency (see Flavell, 1970; Ornstein, 1978). Memory is one of the functions known to decline with age (Botwinick, 1973). In free-recall tasks, elderly subjects use organizational strategies less frequently or less efficiently than do younger adults (Craik & Masani, 1967; Denney, 1974; Hultsch, 1971, 1974). Similarly, older subjects report the use of mediational techniques in paired-associate experiments less frequently than do younger adults (Hulicka, Sterns, & Grossman, 1967). All of the decrements may be conceived of as "effortful" processes and hence would conform to the Hasher and Zacks (1979) framework which indicated that the young and elderly will show a decline deficit on those tasks that require substantial capacity (e.g., "effortful" processing).

Where does reward enter the picture as related to memory processes?

In other words the question of whether adequate performance of a task is dependent upon the comprehension of the end-state or is dependent upon increased maturation should be carefully considered. Bower (1970) has suggested that the "important ingredient appears to be cognitive constructive activity itself, not the motivation or reward" which enhances memory (p. 504). Miller, Galanter and Pribram (1960) have also put forth the same thought: "It is the execution of the plan not just the intent to execute it that is important for memory" (p. 130). Of course, Bower's focus upon activity agrees with the Soviet theme which states that "material is remembered most effectively when it is connected with the goal of an activity. Reaching a goal of an activity provides the most effective research format" (Zinchenko, 1962/1979, 1981, p. 339).

In spite of the differing methods and theoretical bases and cultures, and in spite of the narrowness of scope of some of the studies (the research summarized was limited in its perspective since it did not always relate the memory process to cognitive development), the essence of these studies points to the fact that we cannot study memory, attention, organization and reward without specifying the changes in the child and the environment that promote the subordination of actions in memory operations. In other words or in Soviet terms, we need to analyze both the external and internal changes of the individual.

The main factor that emerges in terms of both American and Soviet studies is that we cannot merely study the memory performance, but must also consider the processes involved and the context in which they occur. Hence, our real task lies ahead of us, that is, to investi-

gate and differentiate the external and internal conditions involved in the development of mental structures.

Finally, one commonality that appears to pervade both the American and Soviet studies is that developmental changes, particularly between 2 and 5 years, do not appear to be due to increasing strategy utilization, but to an increasing growth in world knowledge (Myers & Perlmutter, 1978). Thus, one possible factor in considering the precursors for memory development is an automatic or spontaneously functioning system, which also could be tied to other frameworks (e.g., Hasher & Zacks, 1979; Pavlov, 1928; Atkinson-Shiffrin, 1968). The generalization might be made, then, that as the child's cognitive capacity to generate his own memory strategies develop, the necessity for strong external stimuli support is correspondingly reduced. The child, thus, becomes more dependent upon his own mental faculties rather than stimuli from the external environment. Brown (1975) may be correct in suggesting that the factor responsible for memory improvement may be in the "knowing" component itself.

To summarize, we find a close intertwining relationship between memory, attention, and organization with memory viewed as developing from the internalization or inhibition/control of behavior. This internalization is important since it frees the child from overt responding and allows the child to reflect internally upon new solutions. Thus, American and Soviet studies are similar in their results with the exception of the Soviet research looking more closely at the nature of the activity. With this in mind, we arrive at the question as to how we can facilitate and improve our research; possibly by considering a new framework of cognitive processing (e.g., the Soviet

view), which considers the interaction of both internal and external environments.

Prospects

Where are all the experimental models and research findings leading us in terms of the process of internalization as exemplified by Vygotsky? Vygotsky (1930/1978b) indicated that we have barely begun to investigate the internalization process. Are these studies leading us in the right direction? What is needed in the future? What issues need to be clarified? Newell and Simon (1972) stated that "the goal of understanding human performance requires an analysis of strategies useful in particular task environments" which may relate how strategies change and build upon automatic processes (p. 82). If we are going to understand the total situation, we must also analyze how the task variables are assimilated or internalized into the inner environment. First in line is the need to generate a framework for evaluating the full variety of memory behavior. For this, we could turn to Soviet theory (e.g., Vygotsky, 1934/1962) which indicates that an individual's cognitive system plays as important role in determining performance as does information provided from the environment. As Luria (1976) observed "psychology comes primarily to mean the science of the socio-historical shaping of mental activity and of the structures of mental processes which depend utterly on the basic forms of social practice" (p. 164). The control and processing of external stimuli have implications for internal processing. We need to concentrate on both internal and external processes.

In conjunction with Vygotsky's experimental-genetic approach, other

factors such as how stimuli, instructions and contexts influence the subjects' use of external stimuli should be evaluated. Levels-of-processing literature (e.g., Craik & Lockhart, 1972) as well as Leont'ev's (1972/1979, 1981) levels of analysis in terms of activity indicate that there are profound effects of varying instructions. Reese (1976) indicates that there is a need to use research designs that disentangle the age, cohort and time of measurement effects. It appears that if we are to continue accumulating knowledge about developmental changes in memory, we must begin setting up longitudinal investigations of the development of "automatic" processing versus "effortful" processing across the entire life-span from infancy through old age as well as to investigate which factors are responsible for the shift from automatic to effortful processes.

From Luria's (1979) viewpoint, what is needed "is a strategy that combines artificial laboratory models with more natural kinds of observations," based largely on Vygotsky's theory of development (p. 119). This kind of an approach to research could have far-reaching implications for the investigations of social relationships, particularly in the domain of the development of conscience and self-control. In addition, the effects of training/teaching memory strategies should be considered since research suggests that strategies might be taught.

In conclusion, then, it must be noted that the research and models reviewed in this section are integrally linked to the individual's total cognitive development, although increased cognitive development does not really explain memory changes. It is also important to consider that the areas discussed--memory strategies, at-

tention, organization and reward--did not, by any means, cover all the areas that might have been considered. At this point we are at a loss to explain what variables contribute to the age-linked changes in memory performance, but we will begin to understand memory changes if we analyze the individual and cultural contexts in which these changes occur. Vygotsky (1929) has noted that the acquisition of knowledge of the culture is of the essence in the internalization process. The growing child's increase in knowledge may be one of the contributing factors in the development of memory. As Flavell and Wellman (1977) write:

> Older individuals presumably store, retain, and retrieve a great many outputs better or differently than younger ones. They will do so simply because developmental advances in the content or structure of their semantic or conceptual systems render these outputs more familiar, meaningful, conceptually interrelated, subject to inference and gap filling, or otherwise more memorable for them. (p. 4)

Reference Notes

1. McGraw, K. O., & McCullers, J. C. Monetary reward and water-jar task performance: Evidence for a detrimental effect of reward in problem-solving. Paper presented at the meeting of the Southwestern Psychological Association, New orleans, 1976.

2. Moran, J. D., III, & McCullers, J. C. A neglected factor in children's probability learning. Paper presented at the meeting of the southwestern Society for Research in Human development, Dallas, 1978.

3. Moran, J. D., III, McCullers, J. D., & Fabes, R. A. Effects of reward on WAIS subscale performance. In J. C. McCullers (Chair), Detrimental effect of reward and the cognitive processes. Symposium presented at the meeting of the Southwestern Psychological Association, New orleans, 1978.

References

Altom, M. W., & Weil, J. Young children's use of temporal and spatial order information in short-term memory. Journal of Experimental Child Psychology, 1977, 24, 147-163.

Anderson, J. R., & Bower, G. H. Human associative memory. Washington, D.C.: Winston, 1973.

Arenberg, D. Anticipation interval and age differences in verbal learning. Journal of Abnormal Psychology, 1965, 70, 419-425.

Atkinson, R. C., & Shiffrin, R. M. Human memory: A proposed system and its control processes. In K. W. Spence and J. T. Spence (Eds.), The psychology of learning and motivation: Advances in research and theory (Vol. 2). New York: Academic Press, 1968.

Blonsky, P. O. Memory and thinking. Moscow, 1935. In P. P. Blonskii, Selected psychological works. Moscow: Izd. Prosveshchenie, 1964.

Borkowski, J. G., Levers, S. R., & Gruenfelder, T. A. Transfer of mediational strategies in children: The role of activity and awareness during strategy acquisition. Child Development, 1976, 47, 779-786.

Botwinick, J. Aging and behavior. New York: Springer, 1973.

Bousfield, W. A. The occurrence of clustering in the recall of randomly arranged associates. Journal of General Psychology, 1953, 49, 229-240.

Bower, G. H. Analysis of a mnemonic device. American Scientist, 1970, 58, 496-510.

Brown, A. L. The development of memory: Knowing, knowing about knowing, and knowing how to know. In H. Reese (Ed.), Advances in child development and behavior (Vol. 10). New York: Academic Press, 1975.

Brown, A. L. Knowing when, where and how to remember: A problem of metacognition. In R. Glaser (Ed.), Advances in instructional psychology (Vol. 1). Hillsdale, N.J.: Laurence Erlbaum Associates, 1978.

Brown, A. L., & Campione, J. C. Recognition memory for perceptually similar pictures in preschool children. Journal of Experimental Psychology, 1972, 95, 55-62.

Brown, A. L., & Deloache, J. S. Skills, plans, and self-regulation. In R. Siegler (Ed.), Children's thinking: What develops? Hillsdale, N.J.: Laurence Erlbaum Associates, 1978.

Calder, B. J., & Staw, B. M. Self perception of intrinsic and extrinsic motivation. Journal of Personality and Social Psychology, 1975, 31, 599-605.

Canestrari, R. Paced and self-paced learning in young and elderly adults. Journal of Gerontology, 1963, 18, 165-168.

Canestrari, R. E. Age changes in acquisition. In G. A. Talland (Ed.), Human aging and behavior: Recent advances in research and theory. New York: Academic, 1968.

Carter, D. B., Patterson, C. J., & Quasebarth, S. J. Development of children's use of plans for self-control. Cognitive therapy and Research, 1979, 4, 407-413.

Ceci, S. J., & Howe, M. J. Age-related differences in free recall as a function of retrieval flexibility. Journal of Experimental Child Psychology, 1978, 26, 432-442.

Chi, M. T. Short-term memory limitations in chidlren: Capacity or processing deficits? Memory and Cognition, 1976, 4, 559-572.

Chown, S. M. Age and the rigidities. Journal of Gerontology, 1961, 16, 353-362.

Cole, M., John-Steiner, V., Scribner, S., & Souberman, E. Mind in Society. Cambridge, Mass.: Harvard University Press, 1978.

Cole, M., & Scribner, S. Cross-cultural studies of memory and cognition. In R. V. Kail and J. W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, N.J.: Laurence Erlbaum Associates, 1977.

Condry, J. Enemies of exploration: Self-initiated versus other-initiated learning. Journal of Personality and Social Psychology, 1977, 7, 459-477.

Craik, F. I. M. A "levels of analysis" view of memory. In P. Pliner, L. Kramer, and T. Alloway (Eds.), Communication and affect: Language and thought. New York: Academic Press, 1973.

Craik, F. I. M., & Jacoby, L. L. A process view of short-term retention. In F. Restle, R. M. Shiffrin, N. J. Castellan, H. H. Lindman, and D. B. Pisoni (Eds.), Cognitive theory (Vol. 1). Hillsdale, N.J.: Laurence Erlbaum Associates, 1975.

Craik, F. I. M., & Lockhart, R. S. Levels of processing a framework for memory research. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 671-684.

Craik, F. I. M., & Masani, P. A. Age differences in the temporal integration of language. British Journal of Psychology, 1967, 58, 291-299.

Craik, F. I. M., & Tulving, E. Depth of processing and the retention of words in episodic memory. Journal of Experimental Psychology: General, 1975, 104, 268-294.

Csikszentmihalyi, M. Beyond boredom and anxiety. San Francisco: Jossey-Bass, 1975.

Daehler, M. W., & Bukatko, D. Recognition memory for pictures in very young children: Evidence from attentional preferences using a continuous presentation procedure. Child Development, 1977, 48, 693-696.

deCharms, R. Personal causation. New York: Academic Press, 1968.

deCharms, R., & Muir, M. S. Motivation: Social approaches. In M. R. Rosenzweig and L. W. Porter (Eds.), Annual review of psychology (Vol. 29). Palo Alto, California: Annual Review, Inc., 1978.

Deci, E. L. Intrinsic motivation. New York: Plenum, 1975.

Denney, N. W. Clustering in middle and old age. Developmental Psychology, 1974, 10, 471-475.

Dexter, T. F. G., & Garlick, A. H. Psychology in the schoolroom. New York: Longmans, Green, 1902.

Diggory-Farnham, S. Cognitive processes in education. New York: Harper & Row, 1972.

Durkheim, E., & Mauss, M. Primitive classification. Chicago: University of Chicago Press, 1963.

Eimas, P. D. Effects of memory aids on hypothesis behavior and focusing in young children and adults. Journal of Experimental Child Psychology, 1970, 10, 319-336.

Eisdorfer, C., Axelrod, S., & Wilkie, F. Stimulus exposure time as a factor in serial learning in an aged sample. Journal of Abnormal and Social Psychology, 1973, 67, 594-600.

El'konin, D. B. The problem of instruction and development in the works of L. S. Vygotsky. Soviet Psychology, 1967, 12, 34-41. (Voprosy Psikhologil, 1966, 12, 33-41.)

El'konin, D. B. Toward the problem of stages in the mental development of the child. Soviet Psychology, 1972, 3, 225-251.

Engels, F. Dialectics of nature. New York: International Publishers, 1940.

Eriksen, B. A., & Eriksen, C. W. Effects of noise letters upon the identification of a target letter in a nonsearch task. Perception and Psychophysics, 1974, 16, 143-149.

Eysenck, M. W., & Baron, C. R. Effects of caring on recall from categorized word lists. Developmental Psychology, 1974, 10, 665-666.

Fabes, R. A., McCullers, J. C., & Moran, J. D., III. The hidden costs of reward and WAIS subscale performance. American Journal of Psychology, 1981, 94, 387-398.

Fichte, J. G. Addresses to the German nation. Chicago: The Open Court Publishing Co., 1922.

Flavell, J. H. Developmental studies of mediated memory. In H. W. Reese and L. P. Lipsitt (Eds.), Advances in child development and behavior (Vol. 5). New York: Academic Press, 1970.

Flavell, J. H. Cognitive development. Englewood Cliffs, N.J.: Prentice-Hall, 1977.

Flavell, J. H. On cognitive development. Child Development, 1982, 53, 1-10.

Flavell, J. H., & Wellman, H. M. Metamemory. In R. V. Kail and J. W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, N.J.: Laurence Erlbaum Associates, 1977.

Galperin, P. Y. On the notion of internalization. Soviet Psychology, 1967, 5, 28-33.

Galperin, P. Y. Stages in the development of mental acts. In M. Cole and I. Maltzmann (Eds.), A handbook of contemporary Soviet psychology. New York: Basic Books, Inc., 1969.

Gazzaniga, M. S., Steen, D., & Volpe, B. T. Functional neuroscience. New york: Harper & Row, 1979.

Gelfand, H. Organization in free recall learning: Output contiguity and interresponse times as a function of presentation structure. Unpublished doctoral dissertation, University of Michigan, 1971.

Goldberg, S., Perlmutter, M., & Myers, N. Recall of related and unrelated lists by 2-year olds. Journal of Experimental Child Psychology, 1974, 18, 1-8.

Goulet, L. R. The interfaces of acquisition: Models and methods for studying the active, developing organism. In J. R. Nesselroade and H. W. Reese (Eds.), Life-span developmental psychology. New York: Academic Press, 1973.

Hagen, J. W. The effect of distraction on selective attention. Child Development, 1967, 38, 685-694.

Hagen, J. W. Strategies for remembering. In S. Farnham-Diggory (Ed.), Information processing in children. New York: Academic Press, 1972.

Hagen, J. W., & Frisch, S. R. The effect of incidental cues on selective attention. Report No. 57, USPHS Grant HD 01368. Center for Human Growth and Development, University of Michigan, 1968.

Hagen, J. W., & Hale, G. A. The development of attention in children. In A. Pick (Ed.), Minnesota symposia on child psychology (Vol. 7). Minneapolis: University of Minnesota Press, 1973.

Hagen, J. W., Jongeward, R. H., & Kail, R. V. Cognitive perspectives on the development of memory. In H. W. Reese (Ed.), Advances in child development and behavior (Vol. 10). New York: Academic Press, 1975.

Hagen, J. W., & Kail, R. V. The role of attention in perceptual and cognitive development. In W. M. Gruickshank and D. P. Hallahan (Eds.), Perceptual and learning disabilities in children (Vol. 2). Syracuse, N.Y.: Syracuse University press, 1975.

Hagen, J. W., Meacham, J. A., & Mesibov, G. Verbal labeling, rehearsal, and short-term memory. Cognitive Psychology, 1970, 1, 47-58.

Hagen, J. W., & Stanovich, K. E. Strategies of acquisition. In R. V. Kail and J. W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, N.J.: Laurence Erlbaum Associates, 1977.

Hale, G. A. Development of children's attention to stimulus components. In G. Hale and M. Lewis (Eds.), Attention and cognitive development, New York: Plenum, 1979.

Harlow, H. F. Learning and satiation of response in intrinsically motivated complex puzzle performance by monkeys. Journal of Comparative and Physiological Psychology, 1950, 43, 289-294.

Harris, J. E. External memory aids. In U. Neisser (Ed.), Memory Observed: Remembering in natural contexts. San Francisco: W. H. Freeman, 1982.

Hasher, L., & Zacks, R. T. Automatic and effortful processes in memory. Journal of Experimental Psychology: General, 1979, 108, 356-388.

Hulicka, I. M., & Grossman, J. L. Age group comparisons for the use of mediators in paired-associate learning. Journal of Gerentology, 1967, 22, 46-51.

Hulicka, I. M., Sterns, H., & Grossman, J. Age-group comparisons of paired-associate learning as a function of paced and self-paced association and response time. Journal of Gerentology, 1967, 22, 274-280.

Hull, C. L. Principles of behavior. New York: Appleton-Century-Crofts, 1943.

Hultsch, D. F. Adult age differences in free classification and free recall. Developmental Psychology, 1971, 4, 338-342.

Hultsch, D. F. Learning to learn in adulthood. Journal of Gerontology, 1974, 29, 302-308.

Hultsch, D. F. Adult age differences in retrieval: Trace-dependent and cue-dependent forgetting. Developmental Psychology, 1975, 11, 197-201.

Istomina, Z. M. The development of voluntary memory in preschool-age children. Soviet Psychology, 1975, 13, 5-64. (Originally published, 1948.)

Kahneman, D. Attention and effort. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1973.

Kail, R. The development of memory in children. San Francisco: W. H. Freeman and Co., 1979. (a)

Kail, R. Use of strategies and individual differences in children's memory. Developmental Psychology, 1979, 3, 251-255 (b)

Kail, R., & Hagen, J. W. Memory in childhood. In B. Wolman (Ed.), Handbook of developmental psychology. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1982.

Kausler, D. H. Retention-forgetting as a nomological network for developmental research. In L. R. Goulet and P. B. Baltes (Eds.), Life-span developmental psychology: Research and theory. New York: Academic Press, 1970.

Klahr, D., & Wallace, J. G. Cognitive development: An information processing view. Hillsdale, N.J.: Laurence Erlbaum Associates, 1976.

Kobasigawa, A. Utilization of retrieval cues by children in recall. Child Development, 1974, 45, 127-134.

Kobasigawa, A. Retrieval strategies. In R. V. Kail and J. W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, N.J.: Laurence Erlbaum, 1977.

Kobasigawa, A., & Orr, R. R. Free recall and retrieval speed of categorized items by kindergarten children. Journal of Experimental Child Psychology, 1973, 15, 187-192.

Korchin, S. J., & Basowitz, H. Age differences in verbal learning. Journal of Abnormal and Social Psychology, 1957, 54, 64-69.

Kretschmer, E. Physique and character. 1925.

Kreutzer, M. A., Leonard, C., & Flavell, J. H. An interview study of children's knowledge about memory. Monographs of the Society for Research in Child Development, 1975, 40 (1, Serial No. 159).

Kruglanski, A. W. The endogenous-exogenous partition in attribution theory. Psychological Reveiw, 1975, 82, 387-406.

Kruglanski, A. W. Attribution and intrinsic motivation. In M. R. Lepper and D. Greene (Eds.), The hidden costs of reward: New perspectives on the psychology of human motivation. Hillsdale, N.J.: Laurence Erlbaum Associates, 1978.

Kruglanski, A. W., Friedman, I., & Zeevi, G. The effects of extrinsic incentive on some qualitative aspects of task performance. Journal of Personality, 1971, 39, 606-617.

Kruglanski, A. W., Riter, A., Amitai, A., Margolin, B. S., Shabtai, L., & Zaksh, D. Can money enhance intrinsic motivation? A test of the content-consequence hypothesis. Journal of Personality and Social Psychology, 1975, 31, 744-750.

Lane, D. M., & Pearson, D. A. The development of selective attention. Merrill-Palmer Quarterly, 1982, 28, 317-337.

Lenin, V. I. Materialism and empirio-critical comments on a re-actionary philosophy. Moscow: Foreign Language Publishing House, 1909. (English edition, 1952.)

Lenin, V. I. Philosophical notebook (Collected Works, Vol. 29). New York: International Publishers, 1929.

Leont'ev, A. N. Studies on the cultural development of the child: III The development of voluntary attention in the child. Journal of Genetic Psychology, 1932, 40, 52-83.

Leont'ev, A. N. Problems of mental development. Washington, D.C.: Joint Publications Research Service, 1964. (Originally published, 1959.)

Leont'ev, A. N. The problem of activity in psychology. Soviet Psychology, 1974-1975, 13, 4-33. (Voprosy Filosofil, 1972, 9, 95-108.)

Leont'ev, A. N. The problem of activity in psychology. In J. V. Wertsch (Ed.), The concept of activity. New York: M. E. Sharpe, 1979, 1981. (Voprosy Filosofil, 1972, No. 9, 95-108.)

Lepper, M. R., & Greene, D. Turning play into work: Effects of adult surveillance and extrinsic rewards on children's intrinsic motivation. Journal of Personality and Social Psychology, 1975, 31, 479-486.

Lepper, M. R., & Greene, D. The hidden costs of reward: New perspectives on the psychology of human motivation. Hillsdale, N.J.: Laurence Erlbaum Associates, 1978.

Lepper, M. R., Greene, D., & Nisbett, R. E. Undermining children's intrinsic interest with extrinsic rewards: A test of the "overjustification" hypothesis. Journal of Personality and Social Psychology, 1973, 28, 129-137.

Levine, F. M., & Fasnacht, G. Token rewards may lead to token learning. American Psychologist, 1974, 29, 816-820.

Locke, J. Some thoughts concerning education. London: A. & J. Churchill, 1693.

Lockhart, R. S., Craik, F. I. M., & Jacoby, L. L. Depth of processing, recognition and recall. In J. Brown (Ed.), Recognition and recall. New York: Wiley, 1976.

Luria, A. R. The role of speech in the regulation of normal and abnormal behavior. New York: Pergamon, 1961.

Luria, A. R. Cognitive development: Its cultural and social foundations. Cambridge, Mass.: Harvard University Press, 1976.

Luria, A. R. Vygotsky. In M. Cole and S. Cole (Eds.), The making of mind: A personal account of Soviet psychology. Cambridge, Mass.: Harvard University Press, 1979.

Luria, A. R. Higher cortical functions in man. New York: Basic Books, Inc., 1980. (Originally published in 1966.)

Luria, A. R., & Yudovich, F. A. Speech and the development of mental processes in the child: An experimental investigation. Harmondsworth, Penguin, 1971. (J. Simon, Ed.)

Maccoby, E. E., & Hagen, J. W. Effects of distraction upon central versus incidental recall: Developmental trends. Journal of Experimental Child Psychology, 1965, 2, 280-289.

Marx, K. Capital. Chicago, Illinois: Kerr & Company, 1906-1909.

Matlin, M. Cognition. New York: Holt, Rinehart & Winston, 1983.

McGeoch, J., & Irion, A. The psychology of human learning. New York: McKay, 1961.

McGraw, K. O. The detrimental effects of reward on performance: A literature review and a predictor model. In M. R. Lepper and D. Greene (Eds.), The hidden costs of reward. Hillsdale, N.J.: Laurence Erlbaum Associates, 1978.

McGraw, K. O., & McCullers, J. C. The distracting effect of material reward: An alternative explanation for the superior performance of reward groups in probability learning. Journal of Experimental Child Psychology, 1974, 18 149-158.

McLeish, J. Soviet psychology: History, theory, content. New York: Harper & Row, 1975.

Meacham, J. A. The development of memory abilities in the individual and society. Human development, 1972, 15, 205-228.

Meacham, J. A. Soviet investigations. In R. V. Kail, Jr., and J. W. Hagen (Eds.), Perspectives on the development of memory and cognition. New York: Wiley, 1977.

Meacham, J. A., & Dumitru, J. Prospective remembering and external retrieval cues. JSAS Catalog of Selected Documents in Psychology, 1976, 6, 65 (Ms. No. 1284).

Miller, G. A., Galanter, E., & Pribram, K. H. Plans and the structure of behavior. New York: Holt, Rinehart & Winston, 1960.

Miller, P. H., & Weiss, M. G. Children's attention, allocation, understanding of attention, and performance on the incidental learning task. Child Development, 1981, 52, 1183-1190.

Mischel, H. N., Mischel, W., & Hood, S. Q. The development of knowledge of effective ideation to delay gratification. Unpublished manuscript, Stanford University, 1978.

Mischel, W. Toward a cognitive social learning reconceptualization of personality. Psychological Review, 1973, 80, 252-283.

Mischel, W. Processes in delay of gratification. In L. Berkowitz (Ed.), Advances in social psychology (Vol. 1). New York: Academic Press, 1974.

Mischel, W., & Baker, N. Cognitive appraisals and transformations in delay behavior. Journal of Personality and Social Psychology, 1975, 31, 254-261.

Mischel, W., & Patterson, C. J. Effective plans for self-control. In W. A. Collins (Ed.), Minnesota Symposia on child psychology (Vol. 11). Hillsdale, N.J.: Erlbaum Associates, 1978.

Moely, B. E. Organization in memory. In R. V. Kail and J. W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, N.J.: Laurence Erlbaum Associates, 1977.

Moely, B. E., Olson, F. A., Halwes, T. G., & Flavell, J. H. Production deficiency in young children's clustered recall. Developmental Psychology, 1969, 1, 26-34.

Monge, R., & Hultsch, D. Paired associate learning as a function of adult age and the length of anticipation and inspection intervals. Journal of Gerontology, 1971, 26, 157-162.

Moran, J. D., III. A developmental study of probability learning with two- and three-choice tasks as a function of reward. Unpublished masters thesis, University of Oklahoma, 1975.

Moran, J. D., III. A developmental analysis of the effects of rewards on Wechsler intelligence test performance. Unpublished doctoral dissertation, Oklahoma State University, 1978.

Morrison, F. J., Holmes, D. L., & Haith, M. M. A developmental study of the effect of familiarity on short-term visual memory. Journal of Experimental Child Psychology, 1974, 18, 412-425.

Moynahan, E. D. The development of knowledge concerning the effect of categorization upon free recall. Child Development, 1973, 44, 238-246.

Mozgovoy, V. D. The genetic determination of voluntary attention. Soviet Psychology, 1979, 17, 53-67.

Myers, N. A., & Perlmutter, M. Memory in the years from two to five. In P. Ornstein (Ed.), Memory development in children. Hillsdale, N.J.: Laurence Erlbaum Associates, 1978.

Naus, M. J., & Halasz, F. Developmental perspectives on cognitive processing and semantic memory structure. In L. Cermak and F. I. M. Craik (Eds.), Levels of processing and human memory. Hillsdale, N.J.: Laurence Erlbaum Associates, 1978.

Naus, M. J., Ornstein, P. A., & Hoving, K. L. Developmental implications of multistore and depth-of-processing models of memory. In P. A. Ornstein (Ed.), Memory development in children. Hillsdale, N.J.: Laurence Erlbaum Associates, 1978.

Navon, D., & Gopher, D. On the economy of the human processing system, Psychological Review, 1979, 86, 214-255.

Nelson, K., & Brown, A. L. The semantic-epidsodic distinction in memory development. In P. A. Ornstein (Ed.), Memory development in children. Hillsdale, N.J.: Laurence Erlbaum Associates, 1978.

Newell, A., & Simon, H. A. Human problem solving. Englewood Cliffs, N.J.: Prentice-Hall, 1972.

O'Connor, N. Present-day Russian psychology. New York: Pergamon, 1966.

Ornstein, P. A., & Naus, M. J. Rehearsal processes in children's memory. In P. A. Ornstein (Ed.), Memory development in children. Hillsdale, N.J.: Laurence Erlbaum Associates, 1978.

Ornstein, R. E. The psychology of consciousness. San Francisco: Freeman, 1972.

Paris, S. G. Coordination of means and goals. In P. A. Ornstein, (Ed.), Memory development in children. Hillsdale, N.J.: Laurence Erlbaum Associates, 1978. (a)

Paris, S. G. The development of inference and transformation as memory operations. In P. A. Ornstein (Ed.), Memory development in children. Hillsdale, N.J.: Laurence Erlbaum Associates, 1978. (b)

Paris, S. G., & Lindauer, B. K. The development of cognitive skills during childhood. In B. Wolman (Ed.), Handbook of developmental psychology. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1982.

Patterson, C. J., & Carter, D. B. Attentional determinants of children's self-control in waiting and working situations. Child Development, 1979, 50, 272-275.

Pavlov, I. P. Lectures on conditioned reflexes (Vol. 1). New York: International, 1928.

Pavlov, I. P. Conditioned reflexes and psychiatry (Vol. 2). New York: International, 1941.

Payne, T. R. S. L. Rubenstein and the philosophical foundations of Soviet psychology. New York: Humanities Press, 1968.

Perlmutter, M., Hazen, N., Mitchell, D. B., Grady, J. G., Cavanaugh, J. C., & Flook, J. P. Picture cues and exhaustive search facilitate very young children's memory for location. Developmental Psychology, 1981, 17, 104-110.

Perlmutter, M., & Lange, G. A developmental analysis of recall-recognition distinctions. In P. A. Ornstein (Ed.), Memory development in children. Hillsdale, N.J.: Laurence Erlbaum Associates, 1978.

Perlmutter, M., & Myers, N. A. Recognition memory development in two- to four-year olds. Developmental Psychology, 1974, 3, 447-450.

Perlmutter, M., & Myers, N. A. Development of recall in two- to four-year-old children. Developmental Psychology, 1979, 15, 73-83

Peterson, C. R. Age changes in the effects of processing tasks on pictorial recognition memory. Unpublished doctoral dissertation, University of North Carolina, Chapel Hill, 1977.

Piaget, J. On the development of memory and identity. Worchester, Mass.: Clark University Press, 1968.

Piaget, J. The child and reality: Problems of genetic psychology New York: Grossman Publishers, 1973.

Piaget, J., & Inhelder, B. Memory and intelligence. New York: Basic Books, 1973.

Pick, A. D., & Frankel, G. W. A developmental study of strategies of visual selectivity. Child Development, 1974, 45, 1162-1165.

Posner, M. I., & Snyder, C. R. R. Attention and cognitive control. In R. Solso (Ed.), Information processing and cognition: The Loyola Symposium. Hillsdale, N.J.: Erlbaum Associates, 1975.

Rahmani, L. Soviet Psychology. New York: International Universities Press, Inc., 1973.

Reed, C. F., Cogan, D. C., & Landers, W. F. The effects of incentive cue properties on children's acquisitions of simultaneous discriminations. Journal of Genetic Psychology, 1981, 138, 279-289.

Reese, H. W. The development of memory. In L. P. Lipsitt and H. W. Reese (Eds.), Advances in child development and behavior (Vol. 11). New York: Academic, 1976.

Reitan, R. M., & Davison, L. A. Clinical neuropsychology: Current status and applications. New York: Wiley & Sons, 1974.

Riess, S., & Sushinsky, L. W. Overjustification, competing responses, and the acquisition of intrinsic interest. Journal of Personality and Social Psychology, 1975, 31, 1116-1125.

Ritter, K., Kaprove, B., Fitch, J. P., & Flavell, J. H. The development of retrieval strategies in young children. Cognitive Psychology, 1973, 5, 310-321.

Roodin, M. L., & Gruen, G. E. The role of memory in making transitive judgments. Journal of Experimental Child Psychology, 1970, 10, 264-275.

Russel, W., & Farber, Y. Retention of verbal material as a function of degree of failure experienced in original learning. American Psychologist, 1948, 3.

Sagotsky, G., Patterson, C. J., & Lepper, M. R. Training children's self-control: A field experiment in self-monitoring and goal-setting in the classroom. Journal of Experimental Child Psychology, 1978, 25, 242-253.

Sarafino, E. P., & Stinger, M. A. Developmental factors in the undermining effect of extrinsic rewards on intrinsic interest: Do young children overjustify? Journal of Genetic Psychology, 1981, 138, 291-299.

Scribner, S., & Cole, M. Effects of constrained recall training on children's performance in a verbal memory task. Child Development, 1972, 43, 845-857.

Sears, R. Initation of the repression sequence by experienced failure. Journal of Experimental Psychology, 1937, 20, 570-580.

Sechenov, I. M. Reflexes of the brain. Moscow: Uchpedgiz, 1942. (Originally published in 1863.)

Sechenov, I. M. Biographical sketch and essays. New York: Arno, 1973. (Originally published in 1935.)

Sheingold, K. Developmental differences in intake and storage of visual information. Journal of Experimental Child Psychology, 1973, 16, 1-11.

Sieber, J. E., Kameya, L. J., & Paulson, F. L. Effect of memory support on the problem-solving ability of test-anxious children. Journal of Educational Psychology, 1970, 61, 159-168.

Simon, H. A. Information processing models of cognition. In M. R. Rosenzweig and L. W. Porter (Eds.)., Annual review of psychology (Vol. 30). Palo Alto, California: Annual Reviews, Inc., 1979.

Smirnov, A. A. The influence of set and type of activity on memory. Tv. Inst. Psikhol. Uznadze, AN Gruz SSR. Tbilisi, 1945.

Smirnov, A. A. (Ed.). Problems of the psychology of memory. Moscow: Izd. Akad. Pedag. Nauk RSFSR, 1948.

Smirnov, A. A. Problems of the psychology of memory. New York: Plenum, 1973. (Originally published in 1966.)

Smirnov, A. A., & Zinchenko, P. I. Problems in the psychology of memory. In M. Cole and I. Maltzman (Eds.), A handbook of contemporary Soviet psychology. New York: Basic Books, 1969.

Smith, A. D. Age differences in encoding, storage, and retrieval. In L. W. Poon, J. L. Fozard, L. S. Cermak, D. Arenberg, and L. W. Thompson (Eds.), New directions in memory and aging. Hillsdale, N.J.: Erlbaum Associates, 1980.

Sophian, C., & Hagen, J. W. Involuntary memory and the development of retrieval skills in young children. Journal of Experimental Child Psychology, 1978, 26, 458-471.

Spence, J. T. The distracting effect of material reinforcers in the discrimination learning of lower- and middle-class children. Child Development, 1970, 41, 103-111.

Spence, J. T. Do material rewards enhance the performance of lower-class children? Child Development, 1971, 42, 1461-1470.

Spencer, H. The principles of psychology. New York: D. Appleton & Co., 1895.

Stroop, J. R. Studies of interference in serial verbal reactions. Journal of Experimental Psychology, 1935, 18, 643-662.

Taub, H. A. Paired associates learning as a function of age, rate, and instructions. Journal of Genetic Psychology, 1967, 111, 41-46.

Tenney, Y. J. The child's conception of organization and recall. Journal of Experimental Child Psychology, 1975, 19, 100-114.

Thorndike, E., & Forlano, G. The influence of increase and decrease of the amount of reward upon the rate of learning. Journal of Educational Psychology, 1933, 24, 401-411.

Titchener, E. B. A textbook of psychology. New York: Macmillan & Co., 1915.

Todd, C. M., & Perlmutter, M. Reality recalled by preschool children. In M. Perlmutter (Ed.), New directions for child development, children's memory (Vol. 10). San Francisco: Jossey-Bass, 1980.

Tolman, E. C. Purposive behavior in animals and man. New York: Appleton, 1932.

Tulving, E., & Madigan, S. A. Memory and verbal learning. Annual Review of Psychology, 1970, 21, 437-484.

Viesti, C. R., Jr. Effect of monetary rewards on an insight learning task. Psychonomic Science, 1971, 23, 181-182.

Vliestra, A. G. The effect of strategy training and stimulus saliency on attention and recognition in preschoolers. Journal of Experimental Child Psychology, 1978, 25, 17-32.

Vygotsky, L. S. The problem of the cultural development of the child. Journal of Genetic Psychology, 1929, 36, 415-433.

Vygotsky, L. S. Thought and language. Cambridge, Mass.: MIT Press, 1962. (Originally published in 1934.)

Vygotsky, L. S. The development of perception and attention. In M. Cole, V. John-Steiner, S. Scribner, and E. Souberman (Eds. and trans.), Mind in society. Cambridge, Mass.: Harvard University Press, 1978. (Unpublished manuscript, translated from Tool and Symbol in Children's Development, 1930.) (a)

Vygotsky, L. S. Internalization of higher psychological functions. In M. Cole, V. John-Steiner, S. Scribner, and E. Souberman (Eds. and trans.), Mind in society. Cambridge, Mass.: Harvard University Press, 1978. (Unpublished manuscript, translated from Tool and Symbol in Children's Development, 1930.) (b)

Vygotsky, L. S. Mastery of memory and thinking. In M. Cole, V. John-Steiner, S. Scribner, and E. Souberman (Eds. and trans.), Mind in society. Cambridge, Mass.: Harvard University Press, 1978. (Unpublished manuscript, translated from Tool and Symbol in Children's Development, 1930.) (c)

Vygotsky, L. S. Problems of method. In M. Cole, V. John-Steiner, S. Scribner, and E. Souberman (Eds. and trans.), Mind in society. Cambridge, Mass.: Harvard University Press, 1978. (Reprinted from The history of the development of higher psychological functions, Moscow, 1960.)

Vygotsky, L. S. The development of higher forms of attention in childhood. Soviet Psychology, 1979, 18, 67-115. (Reprinted from N. K. Krupskaya Academy of Communist Education, 1929.)

Vygotsky, L. S. The genesis of higher mental functions. In J. Wertsch (Ed. and trans.), The concept of activity in Soviet psychology. New York: M. E. Sharpe, 1979, 1981. (Reprinted from Razvitie Vysshikk psikhicheskikh funktsii, Moscow, 1960.)

Watson, J. B. Behaviorism. New York: W. W. Norton & Co., 1970. (Originally published in 1930.)

Wertsch, J. V. The concept of activity in Soviet psychology. New York: M. E. Sharpe, 1979, 1981.

White, S. H. Evidence for a hierarchical arrangement of learning processes. In L. P. Lipsitt and C. C. Spiker (Eds.), Advances in child development and behavior (Vol. 2). New York: Academic Press, 1965.

White, S. H. Some general outlines of the matrix of developmental changes between five and seven years. Bulletin of the Orton Society, 1970, 20, 41-57.

Williams, K. G., & Goulet, L. R. The effects of cueing and constraint instructions on children's free recall performance. Journal of Experimental Child Psychology, 1975, 19, 464-475.

Winograd, E., & Simon, E. W. Visual memory and imagery in the aged. In L. W. Poon, J. L. Fozard, L. S. Cermak, D. Arenberg, and L. W. Thompson (Eds.), New directions in memory and aging. Hillsdale, N.J.: Erlbaum, 1980.

Wright, J. C., & Vliestra, A. G. The development of selective attention: From perceptual exploration to logical search. In H. W. Reese (Ed.), Advances in child development and behavior (Vol. 10). New York: Academic Press, 1975.

Yaroshevski, M. G. The founder of objective psychology. In B. Wolman (Ed.), Historical roots of contemporary psychology. New York: Harper & Row, 1968.

Yates, B. T., & Mischel, W. Young children's preferred attentional strategies for delaying gratification. Journal of Personality and Social Psychology, 1979, 37, 286-300.

Yendovitskaya, T. Development of memory. In A. Zaporozhets and D. El'konin (Eds.), The psychology of preschool children. Cambridge, Mass.: MIT Press, 1971.

Zankov, L. V. The theory of memory. In B. Simon (Ed.), Psychology in the Soviet Union. Stanford: Stanford University Press, 1957. (Sovetskaya Pedagogika, 1951, 6, 59-80.)

Zaporozhets, A. V., Zinchenko, V. P., & El'konin, D. B. Development of thinking. In A. V. Zaporozhets and D. B. El'konin (Eds.), The psychology of preschool children. Cambridge, Mass.: MIT Press, 1971. (Originally published in 1964.)

Zinchenko, P. I. Involuntary memory and goal-directedness. In J. V. Wertsch (Ed. and trans.), The concept of activity in Soviet Psychology. New York: M. E. Sharpe, Inc., 1979, 1981. (Moscow: APN RSFSR, 1962, 172-207.

Footnote

[1] Titchener (1915) has written: "In summary, then, attention appears in the human mind at three stages of development: as primary attention, determined by various influences that are able to produce a powerful effect upon the nervous system; as secondary attention, during which the centre of consciousness is held by a certain perception or idea, but is held in face of opposition; and lastly as derived primary attention, when this perception or idea has gained an undisputed ascendancy over its rivals. The attentive consciousness is at first simple; it then becomes complex--reaching indeed, in cases of hesitation and deliberation, a very high degree of complexity; and then it simplifies again. Looking at life in the large, we may say that the period of training or education is a period of secondary attention, and that the following period of achievement and mastery is a period of derived primary attention" (p. 275).

APPENDIX B

CORRESPONDENCE

Oklahoma State University

DEPARTMENT OF FAMILY RELATIONS
AND CHILD DEVELOPMENT

STILLWATER, OKLAHOMA 74074
241 HOME ECONOMICS WEST
(405) 624-5057

Dear Parent:

Ms. Sylvia Buse, a doctoral student in Family Relations and Child Development, is conducting a study concerning memory for colors as part of a research project at Oklahoma State University. The purpose of this study is to administer a series of questions to children of different ages to determine the role of language in memory.

We would appreciate the assistance of your son or daughter in this project. Your child's assistance would consist of answering a short series of questions that will not take more than ten minutes.

The results of this observation will be confidential and will not be used to compare your child with other children on an individual basis. We are interested only in group averages.

Please complete the form below in order for your child to participate in this project and return to the teacher by

Thank you for your interest. I look forward to hearing from you. Either Ms. Buse or I would be pleased to clarify any points or answer any questions you may have. My phone number is 624-5061.

Sincerely,

John C. McCullers, Ph.D.
Professor

jj

PARENTAL PERMISSION FORM

My child, _____, has my permission to participate in the research project described above.

Signed: _____

APPENDIX C

RECORD SHEETS

Experiment 1

RECORD SHEET

NAME: _____
BIRTHDATE: _____
DATE OF TEST: _____
SCHOOL: _____
GRADE: _____
OCCUPATION OF FATHER/MOTHER: _____
AGE: _____

SERIES I RT	SERIES II RT	SERIES III RT
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	9
9	9	9
10	10	10
11	11	11
12	12	12
13	13	13
14	14	14
15	15	15
16	16	16
17	17	17
18	18	18
Score: ____	Score: ____	Score: ____

Understanding of Rules:

Method:

Experiment 2

RECORD SHEET

SUBJECT/SEX:
DATE:
BIRTHDATE:
SCHOOL:
GRADE:
OCCUPATION OF
FATHER/MOTHER:
SIBLINGS/SUBJECT POSITION: 1 2 3 4 5 6 7 8
AGE:

SERIES I RT	SERIES II RT	SERIES III RT
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9
10	10	10
11	11	11
12	12	12
13	13	13
14	14	14
15	15	15
16	16	16
17	17	17
18	18	18
	19	19
	20	20
	21	21
	22	22
	23	23
	24	24
Score: ____	Score: ____	Score: ____

Rule Understanding:
II
III

Method:

APPENDIX D

TEST QUESTIONS: EXPERIMENT 2

Table 4

Series II and Series III Test Questions: Experiment 2

INSTRUCTIONS: This time we will play the same game, but a little differently; these are the rules:

1. "You can say each color only once." (No color name can be used twice.)
2. "Green and yellow cannot be used at all." (forbidden colors)
3. "When the signal goes up and is green, answer as quickly as you can."

Series II (No aid)

1.	Have you a friend?
(2.)[a]	What color is your shirt (blouse)?
3.	Did you ever go on a train?
(4.)	What color are the train engines?
5.	Do you want to be a bigger boy (girl)?
6.	Were you ever at the movies?
7.	Do you like to play in your room?
(8.)	What color is the floor?
(9.)	What color are the walls?
10.	Do you write?
11.	Have you seen violets?
(12.)	What color is violet?
13.	Do you like candy?
14.	Were you ever in the mountains?
(15.)	What color are leaves?
16.	Do you swim?
(17.)	What is your favorite color?
18.	What do you do with a pencil?
19.	Do you like pears?
(20.)	What color are apples?
21.	Do you like to play?
(22.)	What color are trees?
23.	Do you go to school?
(24.)	What color are desks?

What do you think? Did you get them all right? What should you not have said? And what else?

---

[a]Scored questions are given in parentheses.

Table 4 (Continued)

INSTRUCTIONS: 1) You can say a color only once.
2) This time you cannot say blue and red.
3) You can use these cards; they may help you.
4) When the signal goes up and is green, answer as quickly as you can.

Series III (Aids)

1. Do you sometimes take walks?
(2.) What color are the houses?
3. Does the sun shine brightly?
(4.) What color is the sky?
5. Do you like candy?
6. Have you seen roses?
7. Do you like vegetables?
(8.) What color are tomatoes?
(9.) What color are notebooks? Tablets?
10. Have you any toys?
11. Do you play ball?
(12.) What colors are balls?
13. Do you live in the city (town)?
14. Have you watched a parade?
(15.) What color are flags?
16. Have you any books?
(17.) What colors are their covers?
18. When does it get dark?
19. Do you like to go to the store?
(20.) What color are bags?
21. Do you dress yourself?
(22.) What color are socks?
23. Do you draw?
(24.) What color are paints?

What do you think? Did you get them all correct? What should you not have said? And what else?

APPENDIX E

COLOR STIMULI

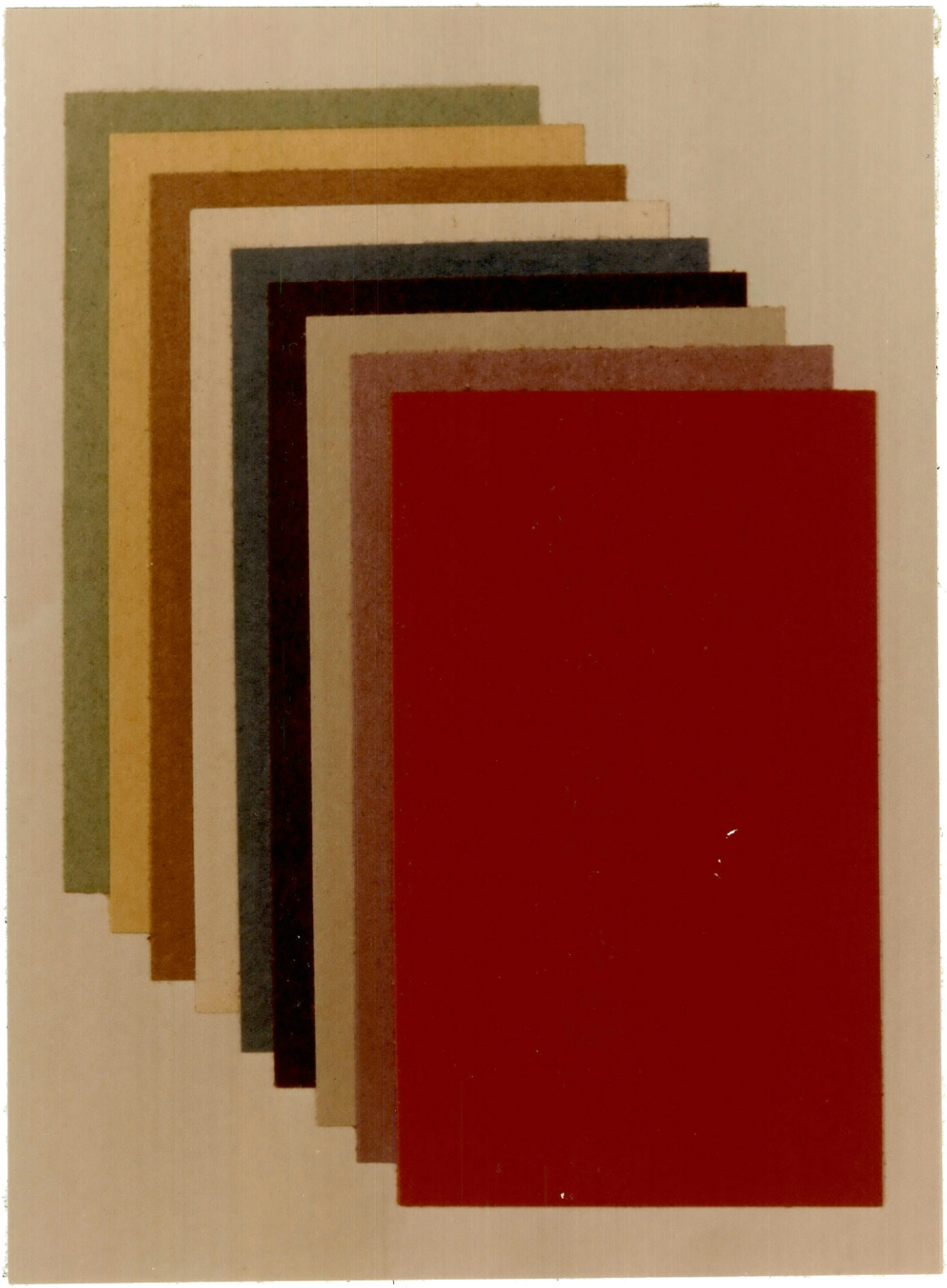
Figure Captions

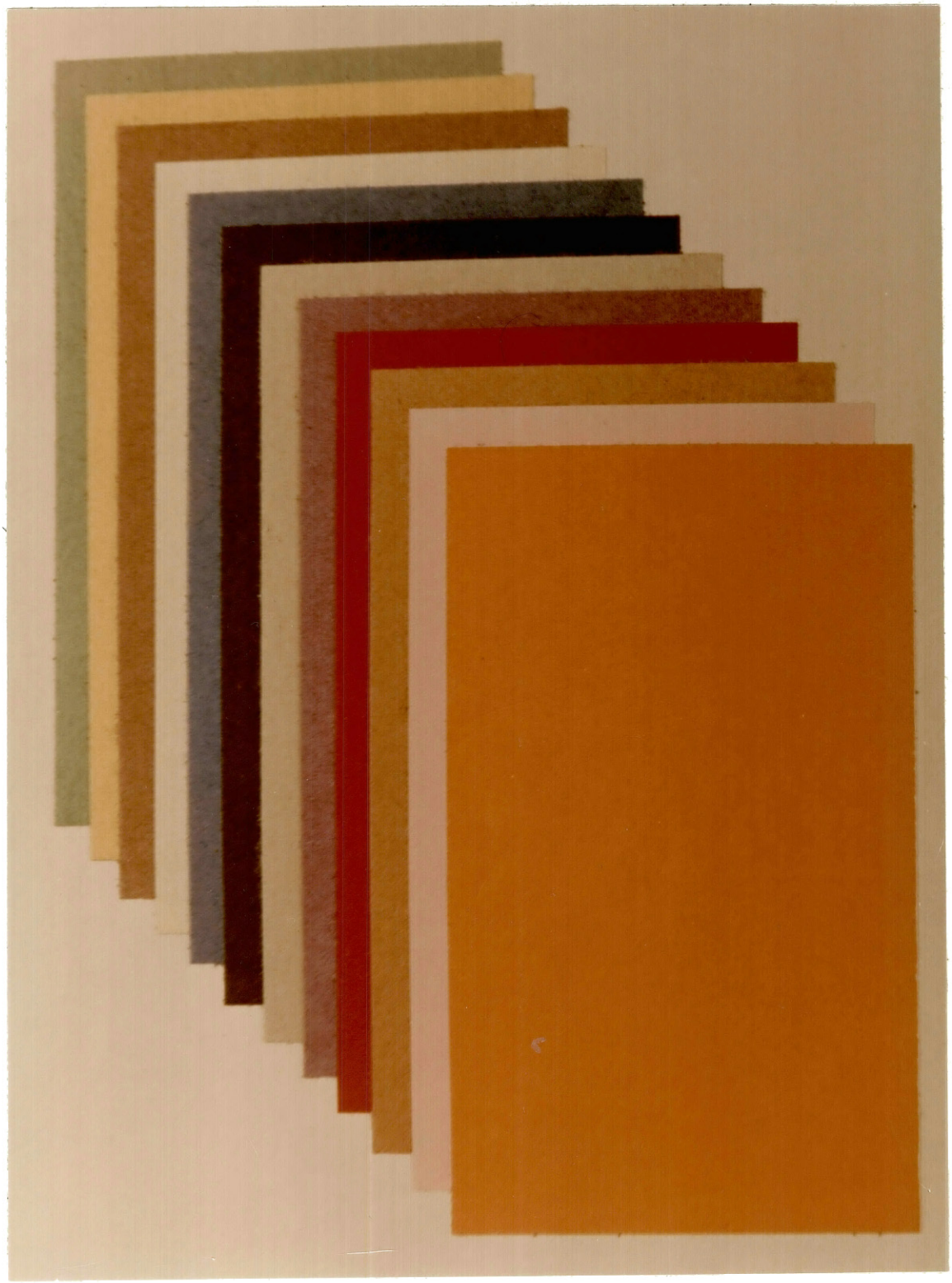
Figure 3. Stimuli for Series III questions: Experiment 1.

Figure 4. Stimuli for Series III questions: Experiment 2.

EXPLANATORY NOTE

The color card stimuli illustrated in Figures 3 and 4 were constructed from sheets of ordinary construction paper, manufactured by Bradner Central Company, Chicago, Illinois, 60606. The stimuli are reproduced in the photographs at the actual size used in the studs (3 x 5 inches). Figure 3 presents the nine color cards used in Study I; the colors, front to back, are: red, purple, gray, black, blue, white, brown, yellow, and green. Figure 4 presents the 12 color cards used in Study II; the colors, back to front, are the same as shown in Figure 3 plus tan, pink, and orange. Although these figures are color photographs, the colors vary slightly from those of the actual stimuli.





APPENDIX F

SUMMARY TABLES OF ANALYSES OF VARIANCE

Table 5

ANOVA for Error scores: Experiment 1

	SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	TAIL PROBABILITY
	MEAN	810.03125	1	810.03125	440.70	0.0000
	CON	5.28125	1	5.28125	2.87	0.0924
	A	354.03125	5	70.80625	38.52	0.0000
	CA	15.53125	5	3.10625	1.69	0.1413
1	ERROR	242.62500	132	1.83807		
	R	2.17014	1	2.17014	2.30	0.1316
	RC	0.28125	1	0.28125	0.30	0.5859
	RA	12.80903	5	2.56181	2.72	0.0227
	RCA	3.78125	5	0.75625	0.80	0.5501
2	ERROR	124.45833	132	0.94287		

Note. CON = Reward/No Reward, A = Age, R = Aids/No Aids

Table 6

ANOVA for Correct Response Latency:

Experiment 1

	SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	TAIL PROBABILITY
	MEAN	561084.72323	1	561084.72323	608.02	0.0000
	CON	2544.81701	1	2544.81701	2.76	0.0992
	A	20820.04915	5	4164.00983	4.51	0.0008
	CA	7263.95221	5	1452.79044	1.57	0.1716
1	ERROR	121810.36911	132	922.80583		
	R	9449.68778	1	9449.68778	16.18	0.0001
	RC	131.08504	1	131.08504	0.22	0.6364
	RA	4033.36944	5	806.67389	1.38	0.2353
	RCA	1843.53055	5	368.70611	0.63	0.6761
2	ERROR	77076.42202	132	583.91229		

Note: CON = Reward/No Reward, A = Age, R = Aids/No Aids

Table 7

ANOVA for Error Scores

Without Oldest Groups: Experiment 1

	SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	TAIL PROBABILITY
	MEAN	720.75000	1	720.75000	358.51	0.0000
	CON	15.18750	1	15.18750	7.55	0.0073
	A	239.70833	3	79.90278	39.74	0.0000
	CA	2.43750	3	0.81250	0.40	0.7504
1	ERROR	176.91667	88	2.01042		
	R	0.33333	1	0.33333	0.28	0.5951
	RC	0.52083	1	0.52083	0.44	0.5066
	RA	7.87500	3	2.62500	2.24	0.0891
	RCA	1.18750	3	0.39583	0.34	0.7980
2	ERROR	103.08333	88	1.17140		

Note: CON = Reward/No Reward, A = Age, R = Aids/No Aids

Table 8

ANOVA for Error Latency

Without Oldest Groups: Experiment 1

	SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	TAIL PROBABILITY
	MEAN	28892.68861	1	28892.68861	96.23	0.0000
	CON	519.20435	1	519.20435	1.73	0.1943
	A	2908.29819	3	969.43273	3.23	0.0297
	CA	220.57915	3	73.52638	0.24	0.8646
1	ERROR	15613.15165	52	300.25292		
	R	850.69456	1	850.69456	3.39	0.0714
	RC	152.33824	1	152.33824	0.61	0.4396
	RA	1042.95910	3	347.65303	1.38	0.2578
	RCA	377.29486	3	125.76495	0.50	0.6833
2	ERROR	13056.41151	52	251.08484		

Note. CON = Reward/No Reward, A = Age, R = Aids/No Aids

Table 9

ANOVA for Correct Response Latency

Without Oldest Groups: Experiment 1

	SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	TAIL PROBABILITY
	MEAN	407400.16081	1	407400.16081	371.58	0.0000
	CON	5396.13583	1	5396.13583	4.92	0.0291
	A	16211.14885	3	5403.71628	4.93	0.0033
	CA	2722.86538	3	907.62179	0.83	0.4821
1	ERROR	95385.54521	87	1096.38558		
	R	10067.95634	1	10067.95634	13.06	0.0005
	RC	347.54333	1	347.54333	0.45	0.5037
	RA	2557.33118	3	852.44373	1.11	0.3511
	RCA	911.05128	3	303.68376	0.39	0.7576
2	ERROR	67047.00731	87	770.65526		

NOTE. CON = Reward/No Reward, A = Age, R = Aids/No Aids

Table 10

ANOVA for Correct Response Latency by Sex: Experiment 1

	SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	TAIL PROBABILITY
	MEAN	437426.70491	1	437426.70491	504.81	0.0000
	CON	154.91830	1	154.91830	0.18	0.6732
	A	16554.82026	5	3310.96405	3.82	0.0030
	SEX	912.71530	1	912.71530	1.05	0.3068
	CA	12897.72556	5	2579.54511	2.98	0.0144
	CS	181.90728	1	181.90728	0.21	0.6477
	AS	5528.57674	5	1105.71535	1.28	0.2787
	CAS	11525.11924	5	2305.02385	2.66	0.0256
1	ERROR	103982.58379	120	866.52153		
	R	8111.47795	1	8111.47795	13.72	0.0003
	RC	6.48127	1	6.48127	0.01	0.9168
	RA	2303.24693	5	460.64939	0.78	0.5664
	RS	1516.10035	1	1516.10035	2.57	0.1119
	RCA	2353.31327	5	470.66265	0.80	0.5544
	RCS	15.39827	1	15.39827	0.03	0.8720
	RAS	2049.23087	5	409.84617	0.69	0.6294
	RCAS	2000.92532	5	400.18506	0.68	0.6416
2	ERROR	70923.92173	120	591.03268		

Table 11

ANOVA for Error Scores by Sex:

Experiment 2

	SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	TAIL PROBABILITY
	MEAN	379.78538	1	379.78538	132.12	0.0000
	CON	2.85318	1	2.85318	0.99	0.3271
	SEX	0.87013	1	0.87013	0.30	0.5863
	CS	4.37860	1	4.37860	1.52	0.2267
1	ERROR	86.23750	30	2.87458		
	R	10.35939	1	10.35939	5.90	0.0214
	RC	0.21363	1	0.21363	0.12	0.7297
	RS	2.16278	1	2.16278	1.23	0.2760
	RCS	0.37634	1	0.37634	0.21	0.6468
2	ERROR	52.70417	30	1.75681		

Note. CON = Reward/No Reward, A = Age, R = Aids/No Aids, S = Sex

Table 12

ANOVA for Correct Response

Latency by Sex: Experiment 2

	SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F	TAIL PROBABILITY
	MEAN	2056.72928	1	2056.72928	145.65	0.0000
	CON	5.65601	1	5.65601	0.40	0.5316
	SEX	33.52547	1	33.52547	2.37	0.1338
	CS	116.68450	1	116.68450	8.26	0.0074
1	ERROR	423.63058	30	14.12102		
	R	55.81359	1	55.81359	2.88	0.1000
	RC	18.44073	1	18.44073	0.95	0.3370
	RS	6.65599	1	6.65599	0.34	0.5622
	RCS	15.53395	1	15.53395	0.80	0.3777
2	ERROR	581.17653	30	19.37255		

Note. CON = Reward/No Reward, A = Age, R = Aids/No Aids, S = Sex

APPENDIX G

TABLES OF CELL MEANS

LIST OF SYMBOLS FOR CELL MEANS

A = Age:

9 = preschool
1 = first grade
2 = third grade
3 = sixth grade
4 = college
5 = elderly

CON = Reward/No Reward

1 = Reward
2 = No Reward

E_1 = Mean number of errors in no aid condition

E_2 = Mean number of errors in aid condition

R = Aid/No Aid

1 = No Aid
2 = Aid

Table 13

Cell Means and Standard Deviations

For Error Scores: Experiment 1

CELL MEANS FOR 1-ST DEPENDENT VARIABLE

	CON =	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 2.0000
	A =	* 1.0000	* 2.0000	* 3.0000	* 4.0000	* 5.0000	* 9.0000	* 1.0000	* 2.0000	* 3.0000
	R									
E1	1	1.75000	1.08333	0.75000	0.50000	1.75000	3.08333	2.41667	1.50000	1.00000
E2	2	2.16667	0.66667	0.50000	0.16667	2.83333	3.25000	2.83333	1.08333	0.83333
	MARGINAL	1.95833	0.87500	0.62500	0.33333	2.29167	3.16667	2.62500	1.29167	0.91667
	COUNT	12	12	12	12	12	12	12	12	12

	CON =	* 2.0000	* 2.0000	* 2.0000	MARGINAL
	A =	* 4.0000	* 5.0000	* 9.0000	
	R				
E1	1	0.08333	1.58333	3.58333	1.59028
E2	2	0.33333	2.00000	4.50000	1.76389
	MARGINAL	0.20833	1.79167	4.04167	1.67708
	COUNT	12	12	12	144

STANDARD DEVIATIONS FOR 1-ST DEPENDENT VARIABLE

	CON =	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 2.0000
	A =	* 1.0000	* 2.0000	* 3.0000	* 4.0000	* 5.0000	* 9.0000	* 1.0000	* 2.0000	* 3.0000
	R									
E1	1	1.13818	0.79296	0.62158	0.90453	1.05529	1.62135	1.31137	1.08711	0.95346
E2	2	1.40346	0.98473	1.00000	0.38925	1.11464	1.28806	1.89896	1.31137	1.46680

	CON =	* 2.0000	* 2.0000	* 2.0000
	A =	* 4.0000	* 5.0000	* 9.0000
	R			
E1	1	0.28868	1.24011	1.50504
E2	2	0.49237	1.65145	1.16775

Table 14

Cell Means and Standard Deviations for Error Latency:

Experiment 1

		Reward					No Reward				
		Series II			Series III			Series II		Series III	
Age	n[a]	No Aid	S.D.	n	Aid	S.D.	n	No Aid	S.D.	Aid	S.D.
4-5 years	12	17.33	12.06	(12)	25.08	24.52	12	17.92	20.67	20.67	9.33
16-7 years	12(11)	20.45	12.12	(10)	37.7	25.16	12(11)	18.50	19.50	26.3	13.86
8-9 years	12(9)	15.44	14.76	(4)	21.6	22.9	12(11)	14.0	3.74	8.52	7.90
10-12 years	12(8)	7.58	8.07	(3)	31.6	36.14	12(9)	8.33	10.84	10.6	8.20
18-30 years	12(4)	3.58	7.61	(2)	10.0	3.89	12(1)	0.17	0.58	4.5	1.7
64-85 years	12	9.25	8.09	(12)	27.0	15.76	12(9)	11.08	9.60	31.56	17.45

[a]Numbers in parentheses indicate the number of children making errors.

Table 15

Cell Means and Standard Deviations

For Correct Response Latency: Experiment 1

CELL MEANS FOR 1-ST DEPENDENT VARIABLE

	CON =	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000	MARGINAL
	A =	* 1.0000	* 2.0000	* 3.0000	* 9.0000	* 1.0000	* 2.0000	* 3.0000	* 9.0000	
	R									
E1	1	1.75000	1.08333	0.75000	3.08333	2.41667	1.50000	1.00000	3.58333	1.89583
E2	2	2.16667	0.66667	0.50000	3.25000	2.83333	1.08333	0.83333	4.50000	1.97917
	MARGINAL	1.95833	0.87500	0.62500	3.16667	2.62500	1.29167	0.91667	4.04167	1.93750
	COUNT	12	12	12	12	12	12	12	12	96

STANDARD DEVIATIONS FOR 1-ST DEPENDENT VARIABLE

	CON =	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000
	A =	* 1.0000	* 2.0000	* 3.0000	* 9.0000	* 1.0000	* 2.0000	* 3.0000	* 9.0000
	R								
E1	1	1.13818	0.79296	0.62158	1.62135	1.31137	1.08711	0.95346	1.50504
E2	2	1.40346	0.98473	1.00000	1.28806	1.89896	1.31137	1.46680	1.16775

Table 16

Cell Means and Standard Deviations for Error Scores

Without Oldest Groups:

Experiment 1

CELL MEANS FOR 1-ST DEPENDENT VARIABLE

	CON	=	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000	MARGINAL
	A	=	* 1.0000	* 2.0000	* 3.0000	* 9.0000	* 1.0000	* 2.0000	* 3.0000	* 9.0000	
	R										
E1	1		1.75000	1.08333	0.75000	3.08333	2.41667	1.50000	1.00000	3.58333	1.89583
E2	2		2.16667	0.66667	0.50000	3.25000	2.83333	1.08333	0.83333	4.50000	1.97917
	MARGINAL		1.95833	0.87500	0.62500	3.16667	2.62500	1.29167	0.91667	4.04167	1.93750
	COUNT		12	12	12	12	12	12	12	12	96

STANDARD DEVIATIONS FOR 1-ST DEPENDENT VARIABLE

	CON	=	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000
	A	=	* 1.0000	* 2.0000	* 3.0000	* 9.0000	* 1.0000	* 2.0000	* 3.0000	* 9.0000
	R									
E1	1		1.13818	0.79296	0.62158	1.62135	1.31137	1.08711	0.95346	1.50504
E2	2		1.40346	0.98473	1.00000	1.28806	1.89896	1.31137	1.46680	1.16775

Table 17

Cell Means and Standard Deviations for Error Latency

Without Oldest Groups:

Experiment 1

CELL MEANS FOR 1-ST DEPENDENT VARIABLE

	CON =	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000	MARGINAL
	A =	* 1.0000	* 2.0000	* 3.0000	* 9.0000	* 1.0000	* 2.0000	* 3.0000	* 9.0000	
	R									
ER1	1	19.11111	10.50000	19.00000	17.33333	17.90000	10.27143	10.75000	17.91667	16.14833
ER2	2	41.55556	24.50000	11.00000	25.08333	28.00000	9.09143	13.75000	20.66667	24.02733
MARGINAL		30.33333	17.50000	15.00000	21.20833	22.95000	9.68143	12.25000	19.29167	20.08783
COUNT		9	4	2	12	10	7	4	12	60

STANDARD DEVIATIONS FOR 1-ST DEPENDENT VARIABLE

	CON =	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000
	A =	* 1.0000	* 2.0000	* 3.0000	* 9.0000	* 1.0000	* 2.0000	* 3.0000	* 9.0000
	R								
ER1	1	12.73229	4.93288	12.72792	12.05543	18.96459	8.29753	11.52895	20.67259
ER2	2	23.34048	25.40997	7.07107	24.52256	14.18136	7.30058	15.75595	9.31600

Table 18

Cell Means and Standard Deviations for Correct Latency

Without Oldest Groups:

Experiment 1

CELL MEANS FOR 1-ST DEPENDENT VARIABLE

	CON =	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000	MARGINAL
	A =	* 1.0000	* 2.0000	* 3.0000	* 9.0000	* 1.0000	* 2.0000	* 3.0000	* 9.0000	
	R									
CR1	1	42.08333	53.75000	39.66667	36.58333	33.45833	40.52500	44.00000	22.27273	39.21895
CR2	2	67.00000	63.33333	66.66667	44.16667	43.58333	58.93333	64.08333	21.09091	53.94947
	MARGINAL	54.54167	58.54167	53.16667	40.37500	38.52083	49.72917	54.04167	21.68182	46.58421
	COUNT	12	12	12	12	12	12	12	11	95

STANDARD DEVIATIONS FOR 1-ST DEPENDENT VARIABLE

	CON =	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000
	A =	* 1.0000	* 2.0000	* 3.0000	* 9.0000	* 1.0000	* 2.0000	* 3.0000	* 9.0000
	R								
CR1	1	18.47582	21.54119	11.22767	36.25781	27.28091	24.40704	28.29391	21.14280
CR2	2	40.70515	23.44562	53.23760	22.69495	43.36622	28.57591	38.85511	15.22796

Table 19

Cell Means and Standard Deviations for Correct Response Latency by Sex: Experiment 1

CELL MEANS FOR 1-ST DEPENDENT VARIABLE

	CON =	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000
	A =	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 3.0000	* 3.0000	* 4.0000	* 4.0000	* 5.0000
	SEX =	* 1.0000	* 2.0000	* 1.0000	* 2.0000	* 1.0000	* 2.0000	* 1.0000	* 2.0000	* 1.0000
	R									
CR1	1	45.62500	35.00000	58.00000	50.71429	46.00000	36.50000	35.18182	12.00000	41.11111
CR2	2	66.62500	67.75000	51.20000	72.00000	49.50000	75.25000	42.90909	28.00000	41.66667
	MARGINAL	56.12500	51.37500	54.60000	61.35714	47.75000	55.87500	39.04545	20.00000	41.38889
	COUNT	8	4	5	7	4	8	11	1	9
	CON =	* 1.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000
	A =	* 5.0000	* 9.0000	* 9.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 3.0000	* 3.0000
	SEX =	* 2.0000	* 1.0000	* 2.0000	* 1.0000	* 2.0000	* 1.0000	* 2.0000	* 1.0000	* 2.0000
	R									
CR1	1	32.33333	44.66667	33.88889	39.64286	24.80000	53.55000	27.50000	57.75000	37.12500
CR2	2	28.00000	59.00000	39.22222	35.42857	55.00000	65.20000	52.66667	78.75000	56.75000
	MARGINAL	30.16667	51.83333	36.55556	37.53571	39.90000	59.37500	40.08333	68.25000	46.93750
	COUNT	3	3	9	7	5	6	6	4	8

Table 19 (Continued)

								MARGINAL		
CON	=	* 2.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000			
A	=	* 4.0000	* 4.0000	* 5.0000	* 5.0000	* 9.0000	* 9.0000			
SEX	=	* 1.0000	* 2.0000	* 1.0000	* 2.0000	* 1.0000	* 2.0000			
R										
CR1	1	36.28571	38.86000	33.22222	62.66667	28.00000	15.57143	38.41042		
CR2	2	39.00000	37.12000	39.22222	95.00000	33.40000	9.28571	49.86667		
MARGINAL		37.64286	37.99000	36.22222	78.83333	30.70000	12.42857	44.13854		
COUNT		7	5	9	3	5	7	144		

STANDARD DEVIATIONS FOR 1-ST DEPENDENT VARIABLE

CON	=	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000	* 1.0000
A	=	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 3.0000	* 3.0000	* 4.0000	* 4.0000	* 5.0000
SEX	=	* 1.0000	* 2.0000	* 1.0000	* 2.0000	* 1.0000	* 2.0000	* 1.0000	* 2.0000	* 1.0000
R										
CR1	1	18.23605	19.37352	22.93469	21.77701	8.83176	11.41428	15.05203	0.0	15.64005
CR2	2	34.64076	57.22106	14.95660	25.46239	24.25558	62.84164	18.11328	0.0	15.61249
CON	=	* 1.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000
A	=	* 5.0000	* 9.0000	* 9.0000	* 1.0000	* 1.0000	* 2.0000	* 2.0000	* 3.0000	* 3.0000
SEX	=	* 2.0000	* 1.0000	* 2.0000	* 1.0000	* 2.0000	* 1.0000	* 2.0000	* 1.0000	* 2.0000
R										
CR1	1	35.21837	57.50072	30.79547	33.76724	13.25519	25.37493	16.10900	44.32738	15.93233
CR2	2	16.00000	10.53565	23.88398	21.10179	64.99615	22.02644	34.88648	48.39680	34.41241
CON	=	* 2.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000	* 2.0000			
A	=	* 4.0000	* 4.0000	* 5.0000	* 5.0000	* 9.0000	* 9.0000			
SEX	=	* 1.0000	* 2.0000	* 1.0000	* 2.0000	* 1.0000	* 2.0000			
R										
CR1	1	13.31308	17.39822	16.77631	13.57694	29.49576	11.87234			
CR2	2	12.43651	13.72851	19.82913	40.63250	14.48447	5.64843			

Table 20

Cell Means and Standard Deviations for Error Scores

By Sex: Experiment 2

CELL MEANS FOR 1-ST DEPENDENT VARIABLE

						MARGINAL
	CON	= * 3.0000	* 3.0000	* 4.0000	* 4.0000	
	SEX	= * 1.0000	* 2.0000	* 1.0000	* 2.0000	
	R					
E1	1	2.33333	3.60000	2.70000	2.62500	2.88235
E2	2	2.16667	2.40000	2.00000	1.50000	2.02941
	MARGINAL	2.25000	3.00000	2.35000	2.06250	2.45588
	COUNT	6	10	10	8	34

STANDARD DEVIATIONS FOR 1-ST DEPENDENT VARIABLE

	CON	= * 3.0000	* 3.0000	* 4.0000	* 4.0000
	SEX	= * 1.0000	* 2.0000	* 1.0000	* 2.0000
	R				
E1	1	1.75119	1.71270	0.94868	1.18773
E2	2	2.13698	1.77639	1.41421	1.19523

Table 21

Cell Means and Standard Deviations for Correct Response

Latency by Sex: Experiment 2

CELL MEANS FOR 1-ST DEPENDENT VARIABLE

	CON =	* 3.0000	* 3.0000	* 4.0000	* 4.0000	MARGINAL
	SEX =	* 1.0000	* 2.0000	* 1.0000	* 2.0000	
	R					
CR1	1	5.11667	2.62000	5.07000	5.97500	4.57059
CR2	2	9.65000	3.92000	5.52000	7.10000	6.15000
	MARGINAL	7.38333	3.27000	5.29500	6.53750	5.36029
	COUNT	6	10	10	8	34

STANDARD DEVIATIONS FOR 1-ST DEPENDENT VARIABLE

	CON =	* 3.0000	* 3.0000	* 4.0000	* 4.0000
	SEX =	* 1.0000	* 2.0000	* 1.0000	* 2.0000
	R				
CR1	1	5.70944	2.94196	1.60489	3.82128
CR2	2	7.03612	4.69439	2.69642	4.26313

APPENDIX H

RAW DATA

RAW DATA KEY

Experiment 1

Column

1 = Subject Number

2 = Reward/No reward treatment:

1 = Reward
2 = No reward

3 = Age:

9 = preschool
1 = first grade
2 = third grade
3 = sixth grade
4 = college
5 = elderly

4 = Number of errors in no aid condition (E)

5 = Total latency in seconds per subject to answer 7 questions in no aid condition (TR)

6 = Correct response latency in seconds per subject for total number of questions to be answered correctly in no aid condition (CR)

7 = Error latency in seconds per subject for total number of questions answered incorrectly for no aid condition (ER)

8 = Number of errors in aid condition (E)

9 = Total latency in seconds per subject to answer 7 questions in aid condition (TR)

10 = Correct response latency in seconds per subject for total number of questions answered correctly in aid condition (CR)

11 = Error latency in seconds per subject for total number of questions answered incorrectly in aid condition (ER)

Column

12 = Sex:

1 = female
2 = male

RAW DATA KEY

Experiment 2

Column

1 = Subject Number

2 = Time interval condition:

3 = 0-sec
4 = 3-sec

3 = Age (3rd grade)

4 = Number of errors in no aid condition

5 = Total latency in seconds per subject for no aid condition (TR)

6 = Correct response latency in seconds per subject for total number of questions answered correctly for no aid condition (CR)

7 = Error latency in seconds per subject for total number of questions answered in error for no aid condition (ER)

8 = Number of errors in aid condition

9 = Total latency in seconds per subject for aid condition (TR)

10 = Correct response latency in seconds per subject for total number of questions answered correctly for aid condition (CR)

11 = Error latency in seconds per subject for total number of questions answered in error for aid condition (ER)

12 = Sex:

1 = female
2 = male

Table 22

Raw Data: Experiment 1

Column

1	2	3	4	5	6	7	8	9	10	11	12
1	1	9	4	43.0	14.0	29.0	1	88.0	78.0	10.0	2
2	1	9	5	29.0	7.0	22.0	3	22.0	13.0	9.0	2
3	1	9	5	37.0	13.0	24.0	5	41.0	13.0	28.0	2
4	1	9	3	27.0	14.0	13.0	3	58.0	48.0	10.0	1
5	1	9	4	77.0	53.0	24.0	2	25.0	17.0	8.0	2
6	1	9	4	28.0	9.0	19.0	5	47.0	20.0	27.0	2
7	1	9	5	53.0	9.0	44.0	3	85.0	69.0	16.0	1
8	1	9	1	121.0	111.0	10.0	5	159.0	60.0	99.0	1
9	1	9	1	100.0	97.0	3.0	3	79.0	53.0	26.0	2
10	1	9	2	26.0	20.0	6.0	3	86.0	59.0	27.0	2
11	1	9	1	33.0	29.0	4.0	2	74.0	52.0	22.0	2
12	1	9	2	73.0	63.0	10.0	4	67.0	48.0	19.0	2
13	1	1	1	79.0	69.0	10.0	2	99.0	46.0	53.0	1
14	1	1	1	73.0	53.0	20.0	0	80.0	80.0		1
15	1	1	2	20.0	15.0	5.0	2	89.0	61.0	28.0	2
16	1	1	1	71.0	68.0	3.0	3	153.0	105.0	48.0	1
17	1	1	2	53.0	27.0	26.0	3	59.0	36.0	23.0	1
18	1	1	0	55.0	55.0		1	59.0	56.0	3.0	1
19	1	1	3	76.0	36.0	40.0	4	96.0	13.0	83.0	1
20	1	1	1	96.0	61.0	35.0	1	160.0	150.0	10.0	2
21	1	1	3	54.0	21.0	33.0	0	112.0	112.0		1
22	1	1	1	56.0	36.0	20.0	3	116.0	85.0	31.0	1
23	1	1	2	51.0	36.0	15.0	3	107.0	39.0	68.0	2
24	1	1	4	46.0	28.0	18.0	4	51.0	21.0	30.0	2
25	1	2	2	039.0	029.0	010.0	1	084.0	076.0	008.0	2
26	1	2	1	068.0	053.0	015.0	0	068.0	068.0		2
27	1	2	1	045.0	042.0	003.0	0	107.0	107.0		2
28	1	2	1	067.0	057.0	010.0	1	068.0	065.0	003.0	2
29	1	2	1	077.0	073.0	004.0	0	066.0	066.0		1
30	1	2	2	057.0	032.0	025.0	0	055.0	055.0		1
31	1	2	0	095.0	095.0		1	054.0	044.0	010.0	2
32	1	2	1	044.0	039.0	005.0	2	105.0	046.0	059.0	1
33	1	2	0	087.0	087.0		0	061.0	061.0		1
34	1	2	0	044.0	044.0		0	042.0	042.0		2
35	1	2	2	076.0	059.0	017.0	3	056.0	028.0	028.0	1
36	1	2	2	085.0	035.0	050.0	0	102.0	102.0		2
37	1	3	1	063.0	035.0	028.0	2	034.0	028.0	006.0	2
38	1	3	1	034.0	024.0	010.0	0	219.0	219.0		2
39	1	3	1	034.0	024.0	010.0	1	099.0	083.0	016.0	2
40	1	3	0	038.0	038.0		3	132.0	059.0	073.0	2
41	1	3	1	051.0	044.0	007.0	0	085.0	085.0		1
42	1	3	0	049.0	049.0		0	031.0	031.0		1
43	1	3	1	056.0	046.0	010.0	0	090.0	090.0		2
44	1	3	0	058.0	058.0		0	062.0	062.0		2
45	1	3	0	030.0	030.0		0	034.0	034.0		2
46	1	3	1	068.0	056.0	012.0	0	044.0	044.0		1
47	1	3	1	038.0	035.0	003.0	0	038.0	038.0		1
48	1	3	2	048.0	037.0	011.0	0	027.0	027.0		2
49	1	4	3	021.0	012.0	009.0	0	028.0	028.0		2
50	1	4	0	021.0	021.0		0	030.0	030.0		1
51	1	4	1	025.0	022.0	003.0	0	073.0	073.0		1
52	1	4	1	035.0	030.0	005.0	0	023.0	023.0		1
53	1	4	0	032.0	032.0		0	036.0	036.0		1
54	1	4	0	031.0	031.0		0	039.0	039.0		1
55	1	4	0	064.0	064.0		1	043.0	033.0	010.0	1
56	1	4	1	060.0	034.0	026.0	0	048.0	048.0		1
57	1	4	0	063.0	063.0		1	090.0	080.0	010.0	1
58	1	4	0	025.0	025.0		0	033.0	033.0		1
59	1	4	0	040.0	040.0		0	046.0	046.0		1

Table 22 (Continued)

Column

1	2	3	4	5	6	7	8	9	10	11	12
60	1	4	0	025.0	025.0		0	031.0	031.0		1
61	1	5	2	089.0	064.0	025.0	2	081.0	054.0	037.0	1
62	1	5	3	021.0	012.0	009.0	4	040.0	028.0	012.0	2
63	1	5	2	075.0	066.0	009.0	5	057.0	013.0	044.0	1
64	1	5	1	076.0	073.0	003.0	3	057.0	044.0	013.0	2
65	1	5	2	035.0	032.0	003.0	3	081.0	048.0	033.0	1
66	1	5	2	047.0	039.0	008.0	2	093.0	068.0	025.0	1
67	1	5	1	036.0	033.0	003.0	3	075.0	042.0	033.0	1
68	1	5	0	039.0	039.0		2	039.0	031.0	008.0	1
69	1	5	2	028.0	022.0	006.0	2	068.0	033.0	035.0	1
70	1	5	1	074.0	049.0	025.0	3	073.0	048.0	025.0	1
71	1	5	1	034.0	026.0	008.0	1	041.0	038.0	003.0	1
72	1	5	4	024.0	012.0	012.0	4	068.0	012.0	056.0	2
1	2	9	5	39.0	10.0	29.0	5	78.0	35.0	43.0	1
2	2	9	3	22.0	10.0	12.0	3	60.0	42.0	18.0	1
3	2	9	2	38.0	20.0	18.0	4	79.0	52.0	27.0	1
4	2	9	4	159.0	80.0	79.0	5	52.0	20.0	32.0	1
5	2	9	6	24.0	5.0	19.0	6	23.0	3.0	20.0	2
6	2	9	5	22.0	4.0	18.0	7	20.0		20.0	2
7	2	9	5	18.0	6.0	12.0	3	28.0	14.0	14.0	2
8	2	9	4	17.0	10.0	7.0	4	25.0	14.0	11.0	2
9	2	9	3	35.0	29.0	6.0	5	26.0	13.0	13.0	2
10	2	9	3	27.0	20.0	7.0	4	36.0	18.0	18.0	1
11	2	9	1	27.0	25.0	2.0	4	24.0	12.0	12.0	2
12	2	9	2	36.0	30.0	6.0	4	29.0	9.0	20.0	2
13	2	1	2	43.0	32.0	11.0	3	66.0	28.0	38.0	2
14	2	1	3	76.0	33.0	43.0	0	167.0	167.0		2
15	2	1	4	22.0	10.0	12.0	4	35.0	10.0	25.0	2
16	2	1	5	31.0	11.0	20.0	4	34.0	15.0	19.0	2
17	2	1	2	31.0	24.0	7.0	6	37.0	3.0	34.0	1
18	2	1	2	46.0	38.0	8.0	2	80.0	55.0	25.0	2
19	2	1	1	35.0	30.0	5.0	1	57.0	54.0	3.0	1
20	2	1	2	59.0	40.0	19.0	2	73.0	45.0	28.0	1
21	2	1	2	49.5	33.5	16.0	3	96.0	38.0	58.0	1
22	2	1	3	88.0	18.0	70.0	4	69.0	40.0	29.0	1
23	2	1	3	29.0	18.0	11.0	5	31.0	10.0	21.0	1
24	2	1	0	114.0	114.0		0	58.0	58.0		1
25	2	2	2	043.0	025.0	018.0	1	043.0	039.0	004.0	2
26	2	2	3	038.0	015.0	023.0	2	038.0	015.0	023.0	2
27	2	2	0	089.0	089.0		0	074.0	074.0		1
28	2	2	1	061.0	046.0	015.0	1	061.0	046.0	015.0	2
29	2	2	1	081.0	076.0	005.0	1	081.0	076.0	005.0	1
30	2	2	2	052.0	046.0	006.0	3	052.0	046.0	006.0	1
31	2	2	4	037.0	018.0	019.0	0	119.0	119.0		2
32	2	2	1	030.0	012.0	018.0	0	048.0	048.0		2
33	2	2	1	052.0	049.0	003.0	4	052.0	049.0	003.0	2
34	2	2	1	047.9	039.2	8.0	0	098.2	098.2		1
35	2	2	1	054.0	052.1	001.9	1	065.5	058.9	07.64	1
36	2	2	1	056.2	19.0	37.2	0	038.1	38.1		1
37	2	3	2	024.0	018.0	006.0	1	047.0	043.0	004.0	2
38	2	3	1	034.0	030.0	004.0	1	091.0	081.0	010.0	2
39	2	3	2	056.0	027.0	029.0	0	048.0	048.0		1
40	2	3	2	054.0	026.0	028.0	5	043.0	006.0	037.0	2
41	2	3	1	030.0	025.0	005.0	1	031.0	027.0	004.0	1
42	2	3	0	059.0	059.0		0	120.0	120.0		1
43	2	3	0	056.0	056.0		0	123.0	123.0		2
44	2	3	0	047.0	047.0		2	066.0	053.0	013.0	2
45	2	3	2	051.0	033.0	018.0	0	051.0	051.0		2
46	2	3	2	035.0	025.0	010.0	0	035.0	035.0		2

Table 22 (Continued)

Column											
1	2	3	4	5	6	7	8	9	10	11	12
47	2	3	0	120.0	120.0		0	120.0	120.0		1
48	2	3	0	062.0	062.0		0	062.0	062.0		2
49	2	4	0	035.0	035.0		0	025.0	025.0		2
50	2	4	0	036.0	036.0		1	052.0	048.0	004.0	1
51	2	4	1	060.0	058.0	002.0	1	045.0	042.0	003.0	1
52	2	4	0	041.0	041.0		0	032.0	032.0		1
53	2	4	0	047.0	047.0		0	059.0	059.0		1
54	2	4	0	069.0	069.0		0	033.0	033.0		2
55	2	4	0	034.0	034.0		1	064.0	057.0	007.0	2
56	2	4	0	023.0	023.0		0	021.0	021.0		1
57	2	4	0	024.0	024.0		0	040.0	040.0		1
58	2	4	0	025.0	025.0		1	035.0	031.0	004.0	1
59	2	4	0	024.0	024.0		0	045.0	045.0		2
60	2	4	0	032.3	032.3		0	025.6	025.6		2
61	2	5	2	089.0	061.0	028.0	0	106.0	106.0		2
62	2	5	2	061.0	045.0	016.0	3	092.0	058.0	034.0	1
63	2	5	4	025.0	012.0	013.0	4	068.0	012.0	056.0	1
64	2	5	0	050.0	050.0		1	129.0	069.0	060.0	1
65	2	5	2	051.0	044.0	007.0	3	049.0	026.0	023.0	1
66	2	5	2	031.0	015.0	016.0	2	042.0	036.0	006.0	1
67	2	5	0	050.0	050.0		2	073.0	050.0	023.0	2
68	2	5	3	066.0	040.0	026.0	5	047.0	030.0	017.0	1
69	2	5	2	029.0	017.0	012.0	3	070.0	035.0	035.0	1
70	2	5	1	033.0	021.0	012.0	0	064.0	064.0		1
71	2	5	0	055.0	055.0		0	023.0	023.0		1
72	2	5	1	080.0	077.0	003.0	1	159.0	129.0	030.0	2

Table 23

Raw Data: Experiment 2

Column											
1	2	3	4	5	6	7	8	9	10	11	12
03	4	2	3	9.2	6.9	14.7	1	12.2	12.7	7.0	1
04	4	2	2	6.1	7.0	2.5	0	5.5	5.5		1
06	4	2	2	5.0	5.5	3.0	3	8.6	7.4	11.3	2
07	4	2	4	5.9	7 5	3.5	2	4.3	4.6	3.0	1
08	4	2	1	8.3	5.0	38.0	1	5.0	4.1	13.0	1
09	4	2	2	3.0	3.0	3.0	2	3.0	3.0	3.0	2
10	4	2	1	3.7	3.8	3.0	3	13.3	15.5	8.0	2
19	4	2	4	3.0	3.0	3.0	2	3.3	3.75	1.5	2
20	4	2	2	9.4	7.7	20.0	1	3.5	3.6	3.0	2
11	4	2	3	4.0	3.0	6.3	1	4.2	3.8	8.0	1
12	4	2	4	120.0	14.0	5.5	0	9.6	9.6		2
13	4	2	4	3.0	3.0	3.0	4	3.7	3.7	3.75	1
14	4	2	2	7.2	4.0	20.0	3	3.5	3.7	3.0	1
15	4	2	2	6.9	7.8	3.0	1	7.0	4.8	27.0	2
16	4	2	2	9.5	5.0	27.5	3	5.6	5.9	18.66	1
17	4	2	4	5.5	3.0	9.250		9.2	9.2		2
18	4	2	3	5.1	4.9	5.661		6.1	6.4	3.0	1
05	4	2	3	4.2	4.4	3.3	4	5.1	4.8	5.5	1
01	3	2	5	0.5	0.5	0.5	3	5.95	6.6	4.3	2
02	3	2	1	3.0	3.0	3.0	0	17.4	17.4		1
03	3	2	1	11.9	9.5	41.0	1	5.75	6.17	2.0	1
04	3	2	2	1.6	1.8	0.5	5	4.05	5.2	2.9	1
05	3	2	4	0.75	0.92	0.5	6	1.4	0.5	2.0	2
06	3	2	5	5.4	8.2	2.601		3.6	3.9	0.5	2
07	3	2	1	2.8	2.0	10.0	2	10.1	7.9	19.0	2
08	3	2	4	6.35	0.75	14.754		12.15	19.9	0.5	1
09	3	2	2	4.65	5.1	2.753		2.65	2.5	3.0	2
10	3	2	6	0.5	0.50	0.503		0.5	0.5	0.5	2
11	3	2	4	2.5	0.75	10.251		0.85	0.5	4.0	2
13	3	2	4	1.7	0.58	3.384		0.80	1.0	0.5	2
14	3	2	5	1.0	1.0	1.0	3	3.5	4.78	0.5	1
15	3	2	4	3.9	1.0	9.751		13.45	14.90	0.5	2
16	3	2	1	1.47	14.7	14.0	0	4.60	4.6		1
17	3	2	1	8.85	6.8	27.0	0	9.50	0.95		2

Table 24

Adjusted[a] Raw Scores for Experiment 1 vs. Experiment 2

Column											
1	2	3	4	5	6	7	8	9	10	11	12
SUBJECT NO.	CON	AGE	ERRORS	TR	CR	ER	ERRORS	TR	CR	ER	SEX
1	3	2	5	0.5	0.5	0.5	3	5.95	6.6	4.3	2
2	3	2	1	3.0	3.0	3.0	0	17.4	17.4		1
3	3	2	1	11.9	9.5	41.0	1	5.75	6.17	2.0	1
3	4	2	3	9.2	6.9	14.7	1	12.2	12.7	7.0	1
4	3	2	1	1.6	1.8	0.5	5	4.05	5.2	2.9	1
4	4	2	2	6.1	7.0	2.5	0	5.5	5.5		1
5	3	2	4	0.75	0.92	0.5	6	1.4	0.5	2.0	2
5	4	2	3	4.2	4.4	3.3	4	5.1	4.8	5.5	1
6	3	2	5	5.4	8.2	2.60	1	3.6	3.9	0.5	2
6	4	2	2	5.0	5.5	3.0	3	8.6	7.4	11.3	2
7	3	2	1	2.8	2.0	10.0	2	10.1	7.9	19.0	2
7	4	2	4	5.9	7.5	3.5	2	4.3	4.6	3.0	1
8	3	2	4	6.35	0.75	14.75	4	12.15	19.9	0.5	1
8	4	2	1	8.3	5.0	38.0	1	5.0	4.1	13.0	1
9	3	2	2	4.65	5.1	2.75	3	2.65	2.5	3.0	2
9	4	2	2	3.0	3.0	3.0	2	3.0	3.0	3.0	2
10	3	2	6	0.5	0.50	0.50	3	0.5	0.5	0.5	2
10	4	2	1	3.7	3.8	3.0	3	13.3	15.5	8.0	2
11	3	2	4	2.5	0.75	10.25	1	0.85	0.5	4.0	2
11	4	2	3	4.0	3.0	6.3	1	4.2	3.8	8.0	1
12	4	2	4	120.0	14.0	5.5	0	9.6	9.6		2
13	3	2	4	1.7	0.58	3.38	4	0.80	1.0	0.5	2
13	4	2	4	3.0	3.0	3.0	4	3.7	3.7	3.75	1

[a]The mean error scores were adjusted so that Experiment 1 data could be compared with those of Experiment 2. Specifically, the total number of correct responses on the color questions were divided by the total number of color questions; in Experiment 1, the total number of questions was 7; in Experiment 2, it was 10.

Table 24 (Continued)

Column

1	2	3	4	5	6	7	8	9	10	11	12
SUBJECT NO.	CON	AGE	ERRORS	TR	CR	ER	ERRORS	TR	CR	ER	SEX
14	4	2	2	7.2	4.0	20.0	3	3.5	3.7	3.0	1
15	4	2	2	6.9	7.8	3.0	1	7.0	4.8	27.0	2
16	4	2	2	9.5	5.0	27.5	3	5.5	5.9	18.66	1
17	4	2	4	5.5	3.0	9.25	0	9.2	9.2		2
18	4	2	3	5.1	4.9	5.66	1	6.1	6.4	3.0	1
19	4	2	4	3.0	3.0	3.0	2	3.3	3.75	1.5	2
20	4	2	2	9.4	7.7	20.0	1	3.5	3.6	3.0	2
25	1	2	2	5.57	5.80	5.0	1	012.0	12.67	008.0	2
25	2	2	2	06.14	5.0	9.0	1	06.14	06.50	004.0	2
26	1	2	1	09.71	8.83	015.0	0	09.71	9.71		2
26	2	2	3	05.43	03.75	7.7	2	09.28	05.00	07.67	2
27	1	2	1	06.43	07.00	003.0	0	15.28	15.28		2
27	2	2	0	09.71	9.91		0	16.86	16.86		1
28	1	2	1	09.57	9.50	010.0	1	9.71	10.83	003.0	2
28	2	2	1	08.71	7.67	015.0	1	18.00	17.33	015.0	2
29	1	2	1	11.00	12.17	004.0	0	09.43	9.43		1
29	2	2	1	07.67	12.67	005.0	1	10.57	11.00	005.0	1
30	1	2	2	08.14	6.40	12.5	0	07.86	7.86		1
30	2	2	2	11.57	9.20	3.0	3	15.00	13.25	003.0	1
31	1	2	0	13.57	13.57		1	07.71	7.33	010.0	2
31	2	2	4	07.43	6.00	4.75	0	17.00	17.00		2
32	1	2	1	08.28	6.50	005.0	2	15.0	09.20	09.5	1
32	2	2	1	05.82	12.00	018.0	0	06.86	6.86		2
33	1	2	0	12.43	12.43		0	08.71	8.71		1
33	2	2	1	12.85	8.17	003.3	4	05.86	5.67	003.0	2

Table 22 (Continued)

Column											
1	2	3	4	5	6	7	8	9	10	11	12
SUBJECT NO.	CON	AGE	ERRORS	TR	CR	ER	ERRORS	TR	CR	ER	SEX
34	1	2	0	6.28	6.28		0	06.00	6.00		2
34	2	2	1	6.85	6.65	8.0	0	14.02	14.02		1
35	1	2	2	10.86	11.80	8.5	3	8.00	7.00	9.33	1
35	2	2	1	7.70	8.69	1.9	1	09.36	9.81	7.64	1
36	1	2	2	12.14	7.0	25.0	0	14.57	14.57		2
36	2	2	0	08.02	3.17	19.0	0	5.45	5.45		1
14	3	2	5	1.0	1.0	1.0	3	3.5	4.78	.5	1
15	3	2	4	3.9	1.0	9,75	1	13.45	14.90	.5	2
16	3	2	1	1.47	14.7	14.0	0	4.60	4.6		1
17	3	2	1	8.85	6.8	27.0	0	9.50	.95		2

APPENDIX I

CORRELATIONS

Table 25

Correlations Between Error Scores and Correct Response Latencies for Aid and No Aid Groups by Age: Experiment 1

			No Aid					Aid				
Age Group			E	TR	CR	ER		E	TR	CR	ER	
			3	4	5	6		3	4	5	6	
All ages	E	3	1.0000					1.0000				
	TR	4	0.1633	1.0000				-0.0949	1.0000			
	CR	5	-0.5086*	0.8416**	1.0000			-0.4589**	0.8427**	1.0000		
	ER	6	0.3783**	0.4845**	-0.0785	1.0000		0.3739**	0.5546**	-0.0604	1.0000	
			3	4	5	6		3	4	5	6	
Pre-school	E	3	1.0000					1.0000				
	TR	4	0.2474	1.0000				0.2008	1.0000			
	CR	5	-0.5669**	0.8856**	1.0000			0.5084**	0.8366**	1.0000		
	ER	6	0.4979*	0.5385**	0.0855	1.0000		0.3505	0.7419**	0.2709	1.0000	
			3	4	5	6		3	4	5	6	
First grade	E	3	1.0000					1.0000				
	TR	4	0.4497*	1.0000				-0.4662*	1.0000			
	CR	5	-0.7438**	0.7640**	1.0000			0.7219**	0.8535**	1.0000		
	ER	6	0.2736	0.6354**	-0.1318	1.0000		0.3149	0.3378	-0.2273	1.0000	
			3	4	5	6		3	4	5	6	
Third grade	E	3	1.0000					1.0000				
	TR	4	0.4616*	1.0000				-0.2548	1.0000			
	CR	5	-0.6491**	0.8482**	1.0000			0.4976*	0.8556**	1.0000		
	ER	6	0.3512	0.1879	-0.5126**	1.0000		0.1611	0.4885*	0.3866	1.0000	

Note. E = Errors, TR = Total response latency, CR = Correct response latency, ER = Error latency

* $p<.05$
** $p<.01$

Table 25 (Continued)

			No Aid					Aid				
Age Group			E	TR	CR	ER		E	TR	CR	ER	
Sixth grade			3	4	5	6		3	4	5	6	
	E	3	1.0000				3	1.0000				
	TR	4	0.2869	1.0000			4	-0.0579	1.0000			
	CR	5	-0.5860**	0.8972**	1.0000		5	-0.3408	0.9357**	1.0000		
	ER	6	0.4066	0.6384**	-0.0441	1.0000	6	0.6363**	0.6678**	0.0137	1.0000	
			3	4	5	6		3	4	5	6	
College	E	3	1.0000				3	1.0000				
	TR	4	-0.0714	1.0000			4	0.4718*	1.0000			
	CR	5	-0.2825	0.9324**	1.0000		5	0.3341	0.9850**	1.0000		
	ER	6	0.0	0.4179	-0.1179	1.0000	6	0.0	0.5705*	0.4482	1.0000	
			3	4	5	6		3	4	5	6	
Elderly	E	3	1.0000				3	1.0000				
	TR	4	0.2434	1.0000			4	-0.2594	1.0000			
	CR	5	0.4794*	0.9148**	1.0000		5	-0.5930*	0.8134**	1.0000		
	ER	6	0.2186	0.4332	0.0980	1.0000	6	0.1847	0.5119*	-0.0341	1.0000	

v

VITA

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