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Cross-modality semantic integration as a function of depth of processing in third grades

Laura L. Miceli

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CROSS-MODALITY SEMANTIC INTEGRATION AS A FUNCTION OF DEPTH OF PROCESSING IN THIRD GRADERS

A Thesis
Presented to the
Faculty of
California State College,
San Bernardino

In Partial Fulfillment of the Requirements for the Degree
Master of Arts in Psychology

By
Laura L. Miceli
June 1979
CROSS-MODALITY SEMANTIC INTEGRATION AS A FUNCTION OF DEPTH OF PROCESSING IN THIRD GRADERS

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Approved by:
This study examined children's spontaneous integration of semantically relevant pictures and sentences by manipulating levels of processing. In Experiment 1, 48 third graders were presented a series of 24 pictures and sentences, followed by 24 intervening items at a presentation rate of 15 seconds per slide. Each intervening item contained either semantically relevant or irrelevant information in the opposite modality of the original item it corresponded to. Subjects were given either shallow, deep, or intentional processing instructions. In Experiment 2, 16 third graders were presented the same material as in Experiment 1, with intentional instructions, but at a rate of 8 seconds per slide. In a same-different recognition test, the results suggested that cross-modality semantic integration occurred spontaneously when given a viewing time of 15 seconds per slide in all of the depth of processing tasks, but not when given a viewing time of 8 seconds per slide in the intentional condition. These findings are discussed in terms of the differences in memory processing time with children and adults.
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ACKNOWLEDGEMENTS

I wish to extend special thanks to the staffs and students of Morgan and Preston Elementary Schools, Rialto, California and Monterey Elementary School, San Bernardino, California for their help and participation in this study. I also thank my committee members, Chuck Hoffman and Fred Newton, for their constructive comments regarding this research. Finally, I extend my most sincere appreciation and gratitude to my committee chairperson, Kathy Pezdek, without whose support and guidance this research would not have been possible.
INTRODUCTION

Semantic integration refers to the process in memory wherein information that is similar in meaning contributes to the same memory representation and is consequently stored together in memory. This process involves the active interpretation and assimilation of meaningful relationships within existing cognitive structures. Semantic integration is not achieved by means of a conscious effort on the part of the individual. Instead, semantic integration occurs spontaneously due to the nature of memory. Through the process of semantic integration, one improves comprehension and memory for the ideas being communicated by accumulating a holistic representation instead of exclusive disconnected units in memory. For example, comprehension and memory of verbal material appears to involve the spontaneous construction and integration of both unambiguous and inferred semantic relationships (Barclay, 1973).

The study of semantic integration of linguistic material has been an area of growing interest. Several studies have reported that adults spontaneously adopt the process of semantic integration in remembering sentences (Barclay, 1973; Bransford, Barclay, & Franks, 1972; Bransford & Franks, 1971; Harris, 1974; Honeck, 1973). Furthermore, Walsh and Baldwin
(1977), utilizing the Bransford and Franks (1971) paradigm, replicated the Bransford and Franks linguistic abstraction phenomenon with both young adults and elderly subjects. Further evidence supporting the supposition that adults semantically integrate verbal material is found in the research conducted by Potts (1977), indicating that adults integrate linear syllogisms. Finally, adults have also been found to integrate information contained in prose passages (Bransford & McCarrell, 1975).

Children have also been found to make spontaneous assumptions regarding inferred relationships in verbal material. Children often fail to distinguish between the information generated from these assumptions and the information that was actually presented. Studies have found that children demonstrate the ability to implicitly and actively acquire, construct, and retain semantic information implied within independent sentences (Paris & Carter, 1973; Paris & Mahoney, 1974). There is also evidence that suggests that the process of semantic integration is involved in children's reconstruction of short narrative sequences. Brown (1976) presented preschool to fourth grade subjects four pictures in a story which were accompanied with either complete narrative sentences, partial narrative sentences, or no narrative sentences. The subjects were then required to reconstruct the sequence by selecting old items from a set containing actually seen events and two types of new items,
those consistent or inconsistent with the ordered sequence of the story. The findings indicated that all the subjects had difficulty distinguishing new-consistent items from actually experienced old items. Similarly, semantic integration is evident in children's recall of prose passages (Barclay & Reid, 1974).

While the majority of studies have looked at semantic integration as it occurs when dealing with verbal material, some studies have examined the process of semantic integration of pictorial material. The studies which have been conducted in this area have shown that both children and adults retain the meaning of the pictorial stimuli in an integrated, unified representation in memory rather than a series of discrete pictures (Brown, 1976; Paris & Mahoney, 1974; Pezdek, 1978).

Several studies have dealt with semantic integration within a single modality - either verbal or pictorial. However, the present study is concerned with examining the process of cross-modality semantic integration. In essence, this study is interested in determining if semantic integration occurs when third graders are presented information in both verbal and pictorial modalities.

Hypothesizing that cross-modality semantic integration occurs disputes the dual-coding hypothesis which states that information is represented in memory in either a verbal or imaginal memory store (cf. Paivio & Csapo, 1969). These
two memory stores, or coding systems, are said to interact. However, they are distinct memory stores with different means of processing information and they retain different forms in memory. Thus, if one adheres to the dual-coding hypothesis, cross-modality semantic integration would be precluded due to the fact that verbal and pictorial material are retained in separate memory stores depending upon the modality of the information. The concept of semantic integration is based on the premise that pictorial and verbal material are encoded and retained in a common memory store. Therefore, the concept of semantic integration contradicts the basic premise of the dual-coding hypothesis. Furthermore, research in this area has led several investigators to conclude that the evidence from available research is not adequate to support the dual-coding hypothesis. Several researchers suggest that verbal and imaginal stimuli are retained in a common memory store (Goldstein & Chance, 1974; Rosinski, 1977; Standing & Smith, 1975).

Utilizing the Bransford and Franks (1971) paradigm, Rosenberg and Simon (1977) demonstrated that adults integrate information across pictorial and verbal modalities into a single underlying semantic representation. This study utilized four idea sets and instructed subjects to learn pictures and sentences shown to them. When subjects were given a recognition test, they were often confused as to whether they had seen a picture or a sentence which expressed
the same meaning as those presented earlier. Furthermore, the more complex the sentence or picture was, the more likely the subjects were to accept the items. Pezdek (1977) found similar results utilizing a different paradigm. Adults were presented with a series of slides depicting specific scenes in both the pictorial and verbal modalities and were told it was important to comprehend the meaning of each item presented. These slides were later followed by intervening items which contained either semantically relevant or irrelevant information in the opposite modality of the previously shown slides. For example, either a single picture was later followed by a sentence as the intervening item, or a sentence was later followed by a picture as the intervening item. The test items were in the same modality as the original items. The test items were either an integration of the original and intervening items or it was identical to the original items. The obtained value of \( d' \) was lower when there was a semantically relevant intervening item, relative to the effects of a semantically irrelevant intervening item. These results indicate that adults semantically integrate information contained in pictures and sentences. This paradigm has also been used to assess life-span developmental differences in cross-modality semantic integration (Pezdek, Note 1). Results of this study indicate that sixth graders and high school seniors semantically integrate information contained in pictures and sentences while third graders and
elderly adults do not integrate the information.

The main objective of the present study is to determine why the third graders in Pezdek's (Note 1) study did not semantically integrate across modalities. Basically, the absence of cross-modality integration by children could be explained in terms of a mediational deficiency or a production deficiency. A subject is thought to have a mediational deficiency when he is unable to efficiently utilize a potential mediator or strategy even when he is specifically instructed to do so. On the other hand, a production deficiency is implicated when the subject can be induced, through instructions or training, to use a mediator which he did not produce spontaneously.

Some research findings are available to possibly account for the life-span differences reported by Pezdek (Note 1). One study has shown that, when presented with sentences to remember, children between 5 and 7 years old were unable to use implicit relationships to access sentence memory, while children between 11 and 12 years old were able to use inferred relationships to access sentence memory (Paris & Lindauer, 1976). Flavell, Beach, and Chinsky (1966) reported that children between 5 and 7 years old were unlikely to use spontaneous verbal rehearsal after they viewed objects which they had to recall. However, 10 year olds in this study did use a spontaneous verbal rehearsal strategy.

While the above-mentioned studies clearly indicate a
deficiency of some type in young children, they do not shed any light on the precise nature of the deficiency. In other words, these studies do not indicate whether these children have a mediational deficiency or a production deficiency. However, there are several studies, when looked at in conjunction with the above studies, that suggest young children have a production deficiency rather than a mediational deficiency.

Studies which have experimentally induced the use of mediational strategies in children have been found to significantly increase their memory for objects viewed during the presentation phase of the experiments. Levin, Davidson, Wolff, and Citron (1973) showed that second graders and fifth graders perform significantly better on a paired-associate task when given visual imagery instructions in comparison to the regular study-test instructions generally given in paired-associate tasks. Nelson and Kosslyn (1976) reported that by providing verbal labels for pictures during the presentation phase, picture memory was enhanced more for 5 year olds than for adults. Furthermore, it was shown that when 8 year olds were given imagery instructions, their memory for concrete details of a short story was facilitated more than those who did not receive imagery instructions (Pressley, 1976). Similarly, Levin (1973) found that imagery instructions facilitated memory for details in a prose passage in fourth graders who had adequate reading skills but needed
Collectively, these studies indicate that young children do not spontaneously adopt effective mnemonic strategies. It appears that spontaneous instigation of a mnemonic strategy for memorization, as a goal in itself, is not characteristic of the young child (Brown, 1975). Flavell (1970) has pointed out that the development of mnemonic- mediational activity is partly a function of a child's ability to determine which activity is effective for a given task. Based on the above findings, it appears that young children may attempt to mediate learning, but the mnemonic strategy selected is simply not adequate for the particular task. Many other researchers have also concluded that children have a production deficiency (Hagen, Jongeward, & Kail, 1975; Kausler, 1970; Smirnov & Zinchenko, 1969).

Further evidence to support the hypothesis that young children have a production deficiency is substantiated by research utilizing the depth of processing framework proposed by Craik and Lockhart (1972). Essentially, Craik and Lockhart (1972) suggest that the memory trace is a by-product of perceptual analysis and that trace persistence is a positive function of the depth to which the stimulus is analyzed. It should be noted that "depth" implies a greater degree of cognitive or semantic analysis. Several studies have shown that young children benefit from deep processing tasks in incidental learning situations (Eysenck, 1974; Murphy & Brown,
1975; Sykes, 1976; Weiss, Robinson, & Hastie, 1977). This is due to the fact that subjects are engaged in a task which requires a greater degree of semantic analysis without being consciously aware of the fact that the experiment will test their memory for objects viewed during the initial presentation. Thus, they are unknowingly using an appropriate mediational strategy for the task at hand, and in these instances, there is no evidence that indicates the children are unable to use these mediational strategies efficiently.

Therefore, this study was designed to determine if a production deficiency in young children was responsible for the results obtained by Pezdek (Note 1) in her cross-modality semantic integration paradigm. The present study utilized Pezdek's cross-modality semantic integration paradigm. However, an incidental learning situation was included in addition to an intentional learning situation and levels of processing was manipulated as an independent variable. This is due to the fact that it was the strategy utilized by the subject to encode the information in memory that was important for this study.

Third graders were randomly assigned to either a shallow processing condition which involved a counting task, a deep processing condition which involved an imagery-induced pleasantness-rating task, or an intentional condition which required subjects to remember the material presented to them. The subjects viewed a presentation of 48 slides. The first
24 slides were considered the original items and consisted of 12 line-drawings and 12 sentences. The next 24 slides were either semantically relevant or irrelevant intervening items, each presented in the opposite modality of the original slides they corresponded to. These slides were presented sequentially for 15 seconds each. The test items consisted of 24 slides, 12 of which were the original items shown and 12 of which were an integration of the original item and its corresponding intervening item. The subjects had to decide whether or not they had previously seen each test item.

If cross-modality semantic integration occurs, then subjects should have difficulty in recognizing an original test item when a semantically relevant item intervened. However, the subjects should be more likely to recognize an original test item when a semantically irrelevant item intervened than when a relevant item intervened. The signal detection measure of d' indicates the change in recognition sensitivity in differentiating between original items and changed test items. If subjects integrated the original items with the semantically relevant intervening items, they should be less likely to discriminate the original items from the altered test items. Therefore, if semantic integration occurs, the value of d' should be lower when semantically relevant items intervene than when semantically irrelevant items intervene.

The issue of most direct interest in the present study is
how recognition sensitivity (d') changes as a function of encoding instructions. It is hypothesized that the young children in Pezdek's (Note 1) study had a production deficiency; integration did not occur because the subjects were not processing the information at a deep enough level to be aware of the semantic similarity between items, despite their formal differences in modality. Based upon this hypothesis, the present study predicts that, in terms of depth of processing, third graders should semantically integrate significantly more information with the deep processing task than with the shallow processing task. This is due to the fact that the subjects in the deep processing condition are semantically processing the items more than the subjects in the shallow processing condition. Furthermore, no evidence of semantic integration should be seen in the intentional condition since third graders in Pezdek's (Note 1) study were given the same instructions and failed to integrate the information presented to them.
EXPERIMENT 1

METHOD

Subjects

Forty-eight third graders from Preston Elementary School, Rialto, California and Monterey Elementary School, San Bernardino, California participated in this experiment. Students enrolled in remedial reading classes did not participate.

Materials

The presentation slides consisted of 12 basic sets of pictorial material and 12 basic sets of verbal material. Each set contained two presentation items and a test item. In the pictorial category, the original item of a set was always a picture (P₁), while the intervening item was always a sentence. This intervening item was either a semantically relevant sentence (RS) or semantically irrelevant sentence (IS). The test items in the pictorial category were always pictures. On half of the trials the test item was the original item (P₁) presented, while on the other half of the trials the test item was an altered version of the original item (P₂). All of the pictures were simple black-and-white line-drawings. The original picture in the set depicted a
general scene. The relevant intervening sentence described the original picture and also highlighted a particular detail which was either a novel detail in the original picture or else an altered old detail in the original item. The only difference between the original test item ($P_1$) and the changed test item ($P_2$) was that the changed test item included the highlighted detail from the relevant intervening sentence.

In the verbal category, the initial item was always a sentence ($S_1$) and the intervening item was always a relevant picture (RP) or irrelevant picture (IP). The test items in the verbal category were always sentences. On half of the trials the test item was the original sentence ($S_1$), while on the other half of the trials the test item was an altered version of the original sentence ($S_2$). All sentences had similar grammatical structure. The original sentence in the set described a general scene. The relevant intervening picture depicted the scene described in the original sentence and added a specific detail to the scene. While the original test item ($S_1$) was identical to the original sentence, the changed test item ($S_2$) combined the information contained in the original sentence with the information depicted in the intervening picture.

The control condition consisted of six verbal sets containing irrelevant intervening pictures depicting a concrete scene and six pictorial sets containing irrelevant
intervening sentences describing a concrete scene. These intervening items were semantically unrelated to the original items. The material contained in the irrelevant items did not overlap with the other items in the presentation.

**Design**

Each subject was presented both pictorial and verbal stimuli, relevant and irrelevant intervening items, and both original and altered test items. Half of the items in both the verbal and pictorial categories were randomly assigned to the relevant intervening condition while the remaining items were assigned to the irrelevant intervening condition. Half of the pictorial and verbal items assigned to the relevant intervening condition were randomly assigned to be tested with the original test items while the remaining items were assigned to be tested with the changed test items. This identical process was carried out for the material assigned to the irrelevant intervening condition.

One-third of the subjects were randomly assigned to the shallow processing condition, one-third were randomly assigned to the deep processing condition, and the remaining subjects were assigned to the intentional condition. Furthermore, the slides were randomly ordered to produce two different orders of presentation, with the stipulation that no more than three pictures or sentences were presented consecutively. Half of the subjects from each instructional condition were randomly
assigned to the first order of presentation while the remaining subjects were assigned to the second order of presentation. Thus, this design consisted of between-subjects factors of instructional condition and order of presentation. The within-subjects factors included modality of the original item, type of intervening item, and type of test item.

Procedure

During the presentation phase, subjects were presented 24 original items followed by 24 intervening items. Subjects viewed each slide for 15 seconds. The slides were projected onto a Technicolor rear screen projector by a Kodak Ectographic slide projector (Model AF-3) with automatic timer.

Subjects in the shallow processing condition were instructed to perform a counting task. When a sentence was presented, subjects were instructed to read the sentence and count the number of words in the sentence. When a picture was presented, subjects were told to look at the picture and count the number of different objects in the picture.

Subjects in the deep processing condition were instructed to perform an imagery-induced pleasantness-rating task. When a sentence was presented, subjects were instructed to read the sentence, form a color image of the scene described in the sentence, and then rate the pleasantness of the sentence on a three-point scale. Similarly, when a picture was presented, the subjects were instructed to look at the
picture, form a color image of the picture, and then rate the pleasantness of the picture on a three-point scale.

Subjects in the intentional condition were given instructions to remember the information contained in the slides. When a sentence was presented, subjects were told to read the sentence and try to remember what the sentence said because it would be important later on in the experiment. When the subjects were presented with a picture, they were instructed to look at the picture and try to remember what the picture looked like because it would be important later on in the experiment.

The subjects were then given a recognition test. Subjects were instructed to classify each item as "old," one which they had seen before, or "new," one which they had not seen before. It should be noted that the subjects were instructed to read aloud all sentences during the entire experiment to ensure that the subjects were able to read and comprehend the material. Furthermore, the experimenter recorded all of the subjects' answers on the response sheets.
RESULTS

The signal detection measure of d' scores was the dependent variable of primary interest in this experiment. The d' measure indicates the change in recognition sensitivity in differentiating between original items and changed test items. The rejection region for all of the analyses was p < .05.

In each instructional condition, cross-modality semantic integration was tested by comparing the d' scores in the irrelevant and relevant intervening items conditions. If semantic integration occurs, the value of d' should be higher when semantically irrelevant items intervene than when semantically relevant items intervene. Planned comparisons of the values of d' in the relevant and irrelevant intervening items conditions were used to test the prediction of semantic integration. As can be seen in Table 1, the d' scores were significantly higher with irrelevant than relevant intervening items for the shallow processing task (t_{42} = 10.00), the deep processing task (t_{42} = 9.31), and the intentional processing task (t_{42} = 9.77).

To examine more specific patterns of results, an overall analysis of variance was performed on the d' data for the three processing tasks. Within-subjects variables of modality of the original item and the type of intervening item were
Table 1
Mean $d'$ Data for Irrelevant and Relevant Intervening Items as a Function of Processing Task

<table>
<thead>
<tr>
<th>Processing Task</th>
<th>Irrelevant</th>
<th>Relevant</th>
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<tr>
<td>Shallow</td>
<td>2.54</td>
<td>0.79</td>
</tr>
<tr>
<td>Deep</td>
<td>3.15</td>
<td>1.52</td>
</tr>
<tr>
<td>Intentional</td>
<td>3.27</td>
<td>1.56</td>
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also included. As can be seen in Table 2, the effect of original modality on \(d'\) was significant, \(F(1,42)=5.33, MS_\text{e}=12.11\). Subjects' recognition sensitivity was greater when the original items were sentences (\(d'=2.39\)) as compared to pictures (\(d'=1.89\)). Subjects' recognition sensitivity was greater when irrelevant (\(d'=2.99\)) items intervened than when relevant (\(d'=1.29\)) items intervened, \(F(1,42)=49.60, MS_\text{e}=138.69\). There was no significant effect for type of processing task, and the effect of task did not interact with the other variables in the analysis.

Finally, as indicated in Table 2, there was a significant Modality x Intervening Item interaction, \(F(1,42)=11.88, MS_\text{e}=31.47\). With pictures, subjects were more sensitive when irrelevant (\(d'=3.14\)) than relevant (\(d'=0.63\)) items intervened. Similarly, with sentences, subjects were more sensitive when irrelevant (\(d'=2.84\)) than relevant (\(d'=1.95\)) items intervened. A posteriori comparisons revealed that there was a significant difference between the \(d'\) data in the irrelevant and relevant intervening items conditions for both pictures and sentences. However, the difference in \(d'\) between the irrelevant and relevant intervening items was greater when a picture was presented first than when a sentence was presented first. Collectively, these results indicate semantic integration occurred in both the pictorial and verbal modalities. However, there appears to be a greater degree of cross-modality semantic integration when the original item presented was a
<table>
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<th>SS</th>
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<th>MS</th>
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<td>10.94</td>
<td>2.28</td>
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<tr>
<td>Order (O)</td>
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<td>1</td>
<td>14.90</td>
<td>3.11</td>
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<tr>
<td>Original Modality (M)</td>
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<td>Intervening Item (I)</td>
<td>138.69</td>
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<tr>
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<tr>
<td>S(TO)</td>
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<td>SI(TO)</td>
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<td></td>
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<tr>
<td>SNI(TO)</td>
<td>111.31</td>
<td>42</td>
<td>2.65</td>
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</tbody>
</table>

*p < .05
picture than when the original item presented was a sentence.
DISCUSSION

The main purpose in Experiment 1 was to examine cross-modality semantic integration as a function of depth of processing in third graders. The principle predictions were that subjects would semantically integrate significantly more information with the deep processing task than with the shallow processing task. Furthermore, it was postulated that no integration would occur with the intentional processing task. Results from this experiment do not support these predictions. When irrelevant items intervened, subjects' recognition sensitivity was significantly greater than when relevant intervening items intervened in the shallow, deep, and intentional processing tasks. In addition, there were no significant effects of depth of processing on recognition sensitivity. Thus, cross-modality semantic integration occurred in all three processing conditions.

These findings suggest that, regardless of the type of memory instructions the subjects received, they processed the information in such a way that cross-modality semantic integration occurred. However, this finding conflicts with the results obtained by Pezdek (Note 1). In Pezdek's study, there was no significant difference in the d' scores between the relevant (d'=2.07) and irrelevant (d'=2.19) intervening
items conditions. This indicates the third graders in her study did not integrate relevant information presented in two different modalities.

An explanation exists to account for the differences in results obtained by Pezdek and the present study. Subjects in Pezdek's study were given 8 seconds to view each slide during the presentation phase. However, subjects in the present study were given 15 seconds to view each slide during the presentation phase. This increase in presentation time was due to the fact that the shallow and deep processing tasks required more than 8 seconds to complete. It is possible that 8 seconds was not a sufficient amount of time for third graders to adequately process the material presented to them in order for semantic integration to occur. The fact that children integrated the information in all of the processing conditions in the present study suggests that children spontaneously integrate cross-modality information when given sufficient time to process the information in memory. Therefore, a second experiment was conducted to determine if amount of processing time has an effect upon the memory processes in children, in particular, the process of semantic integration.
EXPERIMENT 2

Experiment 2 was conducted to test the hypothesis that third graders process information in such a way that cross-modality semantic integration occurs when given 15 seconds to view each slide during the presentation phase, but not when given 8 seconds to view each slide. This would account for the differences in integration results obtained in Experiment 1 in the present study and results reported by Pezdek (Note 1). Therefore, the same paradigm used in Experiment 1 was used in this experiment. All subjects received the intentional processing instructions and they were only given 8 seconds to view each slide during the presentation phase.

It is hypothesized that third graders are capable of cross-modality semantic integration when given an adequate amount of time to process the information presented to them. While 15 seconds per slide appears to be enough time to process the information, it is hypothesized that 8 seconds does not give third graders sufficient time to adequately process the information presented to them. Thus, it is predicted that there will be no significant difference in recognition sensitivity when comparing the d' data from the irrelevant and relevant intervening items conditions. In other words, it is predicted that cross-modality semantic
integration will not occur in the present experiment.
METHOD

Subjects

Sixteen third graders from Monterey Elementary School, San Bernardino, California and Morgan Elementary School, Rialto, California participated in this study. Students enrolled in remedial reading classes did not participate.

Procedure

The same design and materials used in Experiment 1 were utilized in the present experiment. During the presentation phase, subjects were presented 24 original items followed by 24 intervening items, and viewed each slide for 8 seconds. The slides were projected onto a Technicolor rear screen projector by a Kodak Ectagraphic slide projector (Model AF-3) with automatic timer.

Subjects were given instructions to remember the information presented in the slides. When a sentence was presented, subjects were told to read the sentence aloud and try to remember what the sentence said because it would be important later in the experiment. When the subjects were presented with a picture, they were instructed to look at the picture and try to remember what the picture looked like because it would be important later in the experiment.

In the recognition test, subjects were instructed to
classify each test item as either "old" or "new." Subjects were required to read aloud all sentences during the entire experiment to ensure they were able to read and comprehend the material. Furthermore, the experimenter recorded all of the subjects' answers on the response sheets.
RESULTS

Once again, the signal detection measure of $d'$ scores was the dependent variable of primary interest. To summarize, the signal detection measure of $d'$ indicates the change in recognition sensitivity in discriminating between the original and changed test items. The rejection region for all analyses was $p < .05$.

Semantic integration was tested by comparing the $d'$ data in the relevant and irrelevant intervening items conditions. If integration occurs, the value of $d'$ should be lower when semantically relevant items intervene than when semantically irrelevant items intervene. To determine whether semantic integration occurred, a $t$-test for related samples was utilized in comparing the values of $d'$ in the relevant and irrelevant intervening items conditions. The results indicated there was no significant difference between the $d'$ scores in the relevant ($d' = 2.01$) and irrelevant ($d' = 2.36$) intervening items conditions ($t_{22} = 0.97$). A comparison of the $d'$ data in this experiment and the $d'$ data for the intentional condition in Experiment 1 is presented in Table 3. In comparison to the present experiment, Table 3 shows there was a significant difference between the $d'$ scores in the relevant ($d' = 1.56$) and irrelevant ($d' = 3.27$) intervening items conditions.
in the intentional condition in Experiment 1 ($t_{42} = 9.77$), as predicted by the integration hypothesis.

Table 3

Mean $d'$ Data for Irrelevant and Relevant Intervening Items as a Function of Presentation Time for Intentional Tasks

<table>
<thead>
<tr>
<th>Type of Intervening Item</th>
<th>Presentation Time</th>
<th>Irrelevant</th>
<th>Relevant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8 seconds</td>
<td>2.36</td>
<td>2.01</td>
</tr>
<tr>
<td></td>
<td>15 seconds</td>
<td>3.27</td>
<td>1.56</td>
</tr>
</tbody>
</table>
DISCUSSION

This study predicted that cross-modality semantic integration would not occur when the subjects were given a viewing time of 8 seconds per slide. The present results support this hypothesis and replicates the findings of Pezdek (Note 1). In Experiment 1, subjects demonstrated the ability to semantically integrate cross-modality information when given 15 seconds to view each slide. Collectively, these results suggest that, in processing meaningful information in two different modalities, third graders integrate the information in memory when given adequate time to do so. While it was concluded by Pezdek that third graders did not integrate cross-modality information in memory, it is now apparent that these children can semantically integrate information contained in pictures and sentences in memory. Children in this age group merely need more time to process the information in memory than they were given in the Pezdek study.
GENERAL DISCUSSION

The present study examined semantic integration of information presented in sentences and pictures to third graders. Pezdek (Note 1) reported that third graders did not integrate information presented in two different modalities. Based on this finding, it was hypothesized that the children in Pezdek's study had a production deficiency. It was suggested that integration did not occur because the children were not processing the information at a deep enough level to be aware of the semantic similarity between items, despite their formal differences in modality.

The results of this study, however, suggest that third graders can semantically integrate cross-modality information. As can be seen in Table 1 and Table 3, there was no evidence of integration when children were given 8 seconds to view each slide during the presentation phase; there was strong evidence for integration when the viewing time was increased to 15 seconds per slide. In the 15 seconds viewing condition, subjects' recognition sensitivity was greater when irrelevant items intervened than when relevant items intervened, regardless of the memory instructions the subjects received. In the 8 seconds viewing condition, subjects' recognition sensitivity was essentially the same in both the irrelevant
and relevant intervening items conditions. It should be noted that, by definition, semantic integration occurs spontaneously due to the nature of the memory processes. Thus, it seems plausible to suggest that 8 seconds does not allow children sufficient time to adequately process the information presented to them. Therefore, semantic integration did not occur. However, since integration occurred when the viewing time was increased to 15 seconds per slide, regardless of the type of memory processing instructions the subjects' received, it is suggested that this gave the children sufficient time to process the information in memory, which, in turn, allowed cross-modality semantic integration to occur spontaneously.

Pezdek (Note 1) suggested that a possible explanation for why children did not integrate pictures and sentences in her study was due to the fact that they had separate memory stores for verbal and visual information. This position had been offered by other researchers (cf. Paivio & Csapo, 1969). While Pezdek did not have adequate data to sufficiently address this issue, she rejected this hypothesis as unparsimonious and theoretically implausible. The fact that cross-modality semantic integration occurred in the present study lends support for the notion that children have a single, integrated memory store for verbal and visual information rather than a dual-coding system that stores verbal and visual information in separate memory stores.
The significant main effects of modality of original items and relevancy of intervening items, along with the Modality x Intervening Items interaction need to be examined. Basically, subjects' recognition sensitivity was greater for sentences than pictures and greater when irrelevant items intervened than when relevant items intervened. Furthermore, there was a greater degree of integration when the original item was a picture rather than a sentence. Hence, subjects were more likely to integrate relevant intervening sentences into original pictures than they were to integrate relevant intervening pictures into original sentences. This pattern of results is consistent with the results reported by Pezdek (Note 1). Pezdek offers a plausible explanation for these findings. Basically she suggested that more information was contained in the pictures than in the sentences. Thus, in the verbal condition, a relevant intervening picture contained more information than the original sentence and, therefore, was seen as different from the original sentence. Consequently, the sentence and picture were stored separately. As a result, the relevant items would not be integrated, and at the same time the original sentence would be better recognized. However, in the pictorial condition the relevant intervening sentences contained less information than the original pictures. Therefore, the sentences could be integrated into the stored representations of the pictures without losing much information.
In conclusion, Pezdek reported that older children and young adults integrated cross-modality information while young children and elderly adults did not. While it was first postulated that young children were probably approaching the experimental situation with a production deficiency, the present study indicates that this was not the case. Instead, the children appear to need more time than adults to process the information in memory in order for semantic integration to occur. While semantic integration occurs with adults when given a viewing time of 8 seconds per slide, young children need a viewing time of 15 seconds per slide in order for integration to occur. Thus, the children in Pezdek's (Note 1) study were not operating with a production deficiency; adults merely process information in memory (and therefore integrate it) faster than children do. Based on this finding, further research should be conducted to determine whether the elderly adults in Pezdek's study were unable to integrate cross-modality information due to a production deficiency, a mediational deficiency, or insufficient time to process the information in memory.
APPENDIX 1

VERBAL SET STIMULI

1.) $S_1$: The woman came into the chapel.
   IP: Two boys jumping over a fence.
   $S_1$: The woman came into the chapel.

2.) $S_1$: The boys paddled past the breaking waves.
   IP: A boy and girl playing in the sand.
   $S_1$: The boys paddled past the breaking waves.

3.) $S_1$: The child played with his new toy.
   IP: Two girls sitting at a table with drinks.
   $S_1$: The child played with his new toy.

4.) $S_1$: The bug moved across the wall.
   IP: A boy and girl dancing in a room.
   $S_2$: The spider moved across the wall.

5.) $S_1$: The lantern lit up the room.
   IP: Two boys digging a hole with shovels.
   $S_2$: The lantern lit up the cabin.

6.) $S_1$: The girl enjoyed playing the sport.
   IP: A skyscraper surrounded by many buildings.
   $S_2$: The girl enjoyed playing tennis.

7.) $S_1$: The people looked at the bridge.
   RP: People looking at a covered bridge.
   $S_1$: The people looked at the bridge.

8.) $S_1$: The stream ran below the house.
   RP: A cabin next to a stream in the woods.
   $S_1$: The stream ran below the house.
9.) $S_1$: The flowers were in the middle of the table.
RP: Daisies in a vase in the middle of a table.
$S_2$: The flowers were in the middle of the table.

10.) $S_1$: The man presented an enjoyable concert.
RP: A pianist performing in front of an audience.
$S_2$: The pianist presented an enjoyable concert.

11.) $S_1$: The cook put the pan on the kitchen counter.
RP: A cook setting a frying pan on a kitchen counter.
$S_2$: The cook put the frying pan on the kitchen counter.

12.) $S_1$: The bird was perched atop the tree.
RP: An eagle perched at the top of a tree.
$S_2$: The eagle was at the top of the tree.
APPENDIX 2

PICTORIAL SET STIMULI

1.) $P_1$: Several books sitting on a table.
IS: The cat was curled up on the rocker.
$P_1$: Several books sitting on a table.

2.) $P_1$: A lady's hand with several rings on her fingers.
IS: The bright winter sun came in the window.
$P_1$: A lady's hand with several rings on her fingers.

3.) $P_1$: A lady standing in front of a house.
IS: The birds sang happily in the cage.
$P_1$: A lady standing in front of a house.

4.) $P_1$: A modern house surrounded by bushes.
IS: Papers blew off of the desk.
$P_2$: A modern house surrounded by flowers.

5.) $P_1$: Two dogs playing with a bone.
IS: The woman rode off on her bicycle.
$P_2$: Two dogs playing with a ball.

6.) $P_1$: A violin leaning against a chair.
IS: The caddy followed the golf ball.
$P_2$: A violin leaning against a box.

7.) $P_1$: A man in a suit with a turtleneck shirt.
RS: The man in the suit had on a dark tie.
$P_1$: A man in a suit with a turtleneck shirt.

8.) $P_1$: A courthouse with a flag on the roof.
RS: The flag was on the pole next to the big building.
$P_1$: A courthouse with a flag on the roof.
9.) $P_1$: A car parked next to a tree.
   RS: The car by the tree had ski-racks on it.
   $P_1$: A car parked next to a tree.

10.) $P_1$: A round clock on the wall next to a fireplace.
    RS: The cuckoo clock was next to the fireplace.
    $P_2$: A cuckoo clock on the wall next to a fireplace.

11.) $P_1$: A boy and girl walking with their arms around each other.
    RS: The boy and girl held hands as they walked.
    $P_2$: A boy and girl holding hands as they are walking.

12.) $P_1$: Boys and girls talking to a mailman.
    RS: The little boys talked with the mailman.
    $P_2$: Boys talking to a mailman.
REFERENCE NOTE

REFERENCES


