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Developmental changes in context effects and picture recognition memory

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DEVELOPMENTAL CHANGES IN CONTEXT EFFECTS
AND PICTURE RECOGNITION MEMORY

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

by
Nancy Hancock

Approved by:

Chairperson

Date 6/7/78
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In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Psychology

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ABSTRACT

The role of context effects on recognition memory for pictures was investigated with second and sixth grade children and adults. Subjects were presented slides of 36 pictures in which a central figure appeared in either an appropriate or inappropriate contextual background, or in no context. Test item conditions were factorially crossed with presentation conditions. At test, central items were in appropriate, inappropriate, or no background context conditions. Recognition accuracy for the central item was highest when the test context was the same as the presentation context, regardless of the appropriateness of the context and central item match. This effect was significant at all age levels supporting the presence of encoding specificity with pictorial materials and was evidenced in children as young as seven years.
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1. Percent Correct Recognition Responses Averaged Across Subjects for Each Context Condition
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I would like to express special appreciation and gratitude to Dr. Kathy Pezdek for her unshakeable faith in me, her patience, and encouragement.
INTRODUCTION

The present study investigates context effects as they apply to visual material, and examines whether the effect changes with age. Another way to put the issue is to ask if memory for pictures of objects is affected by the background context in which the pictures are presented and tested. Further, does this effect vary developmentally?

A number of investigations have demonstrated strong influences of context on subsequent recognition memory using verbal stimuli (Bransford & Johnson, 1973; Light & Schurr, 1973; Thomson & Tulving, 1971; Thomson, 1972). Context is defined as the material presented simultaneously with the target stimulus. In verbal studies, context has been defined as a word, nonsense syllable, sentence, or paragraph presented simultaneously or prior to the target stimulus. The underlying assumption is that when a stimulus is presented, it is encoded with respect to the context in which it is seen, producing a trace which incorporates information from both target and context. Retrieval during test must reactivate the trace for recognition memory to occur. The implication has been that recognition of to-be-remembered items is impaired when context is changed from study phase to test phase. Through the work of a number of researchers, it is
by now well documented that context effects can readily be demonstrated in recognition memory for verbal events (Baker & Santa, 1977; Malmi, 1977; Pellegrino & Salzberg, 1975; Light & Carter-Sobell, 1970; Hunt, 1975).

In the typical verbal paradigm, words were tested for recognition in a different environment from which the words appeared during study (Thomson & Tulving, 1971). Under the testing conditions, words studied alone were tested for recognition with new distractors, or words studied as members of word pairs were tested singularly or in different pairs. Target word recognition was poorer when new environments were introduced than when original context was maintained.

Tulving (1972) has argued that words are frequently used in memory studies for reasons of convenience but that the long-range task, of experimental work being done, is to construct a general theory of memory. Therefore, it is relevant to test theories and findings with other kinds of stimuli besides words. Visual memory is a more general skill than verbal memory, hence, it is of interest to study the generalizibility of principles generated on verbal stimuli to visual, pictorial stimuli. Also, memory for previously seen pictures has been found to be extremely good (Shepard, 1967; Standing, Conezio, & Haber, 1970). Standing et. al presented 2,560 pictures and found a hit rate for old pictures of .95 or better even when up to three days elapsed between learning and testing. With the increasing use of
of pictorial stimuli in cognitive research, it is of particular interest to investigate the generalizibility of the context effects findings from verbal to pictoral stimuli.

Biederman and his colleagues were among the first to conduct experiments investigating the role of context effect in picture recognition (Biederman, 1972; Biederman, Glass, & Stacy, 1973). Picture context was manipulated by cutting photographs into six equal-sized sections and then jumbling the parts. Subjects viewed intact and jumbled scenes. The results showed jumbling interfered with recognition of objects in the pictures even when subjects knew where to look and what to look for. Biederman et. al (1973) concluded that picture context is an important variable affecting identification of picture objects.

Another approach to the study of picture memory and context effects was reported by Bower and Karlin (1974). Since recognition memory for common pictures is very high, Bower and Karlin used relatively homogeneous pictures of facial portraits drawn from a college yearbook. Pictures were selected on the basis of nondistinguishing characteristics. All slides were of Caucasians and all males were wearing ties. Any picture of a person with unusual characteristics (e.g., obvious jewelry, hat, or identifying marks) was eliminated. One facial portrait was then used to provide context for a paired member. Subjects viewed 72 slides of male/female pairs and each subject made one of two decisions about the
pairs of slides. Subjects judged the sex of each member of the pair in one block of slides and compatibility (i.e., whether or not they would be friends) in the second block. To test for the generality of context effects from verbal to pictorial stimuli, Bower and Karlin used the verbal paradigm reported by Tulving and Thomson (1971). Bower and Karlin (1974) found no evidence for a strong effect of context upon recognition memory for pictures. The comparisons crucial to the context effect were old pictures in the same pair, old pictures alone, and old pictures paired with new distractors. The mean recognition accuracy in these 3 conditions did not differ.

Since Bower and Karlin's procedures were analogous to the procedures used in studies which have found context effects with word memory (Thomson, 1972; Thomson & Tulving, 1971), their results were interpreted in terms of differences in the ways in which words and faces are stored and retrieved in memory.

Reluctant to accept the implication of storage and retrieval differences between verbal and pictorial stimuli without additional evidence, Winograd and Rivers-Bulkeley (1977) used a similar paradigm to that used by Bower and Karlin (1974) and tested again for context effect with facial portraits. Winograd and Rivers-Bulkeley found that memory for previously studied faces was markedly impaired when the context was altered from study to test. Comparison of the
hit proportion between slides appearing as paired members for study and alone for test was significant. Also, there was a significant difference in hit rates between same context for study and test and substitution where old slides were paired with new distractors. However, there were two procedural differences between Bower and Karlin (1974) and Winograd and Rivers-Bulkeley (1977). The hit proportions in the Winograd and Rivers-Bulkeley study are based on 432 observations compared with 120 observations in Bower and Karlin's experiment. Secondly, compatibility instructions were designed to produce more integrated encoding of the pairs. Where Bower and Karlin's instructions were to rate whether the individuals in the paired slides would be friends, Winograd and Rivers-Bulkeley instructed rating each couple for compatibility on a 3-point scale: 1 = very compatible, 2 = fairly compatible, and 3 = not compatible. It was hypothesized that the 3-point scale would lead to greater unitized encoding. These results were further substantiated by Watkins, Ho, and Tulving's (1976) research where context effects were found using unfamiliar, similar facial pictures. One face was used to provide context for a paired portrait and there was a significant difference in recognition performance between changed and unchanged portrait pairings between presentation and test.

Context effects in picture recognition memory have also been achieved using another type of picture stimuli. Palmer
(1975) demonstrated the importance of contextual scenes for object identification. In this experiment, subjects were presented pairs of items sequentially. The first item was a contextual setting and the second a target object which was presented for 20, 40, 60, or 120 msec. Different pairings of objects and scenes produced three main conditions: appropriate context, inappropriate context, and no context. It was hypothesized if target presentation was sufficiently brief, only partial information could be extracted and responses would be biased toward identifying objects which are consistent with both sensory and contextual information. The probability of correctly identifying an object was highest for the appropriate context condition, lower for the no context condition, and lower still for the inappropriate condition. These results demonstrate that perceptual identification of presented objects depends on context as well as featural characteristics of the object. Further, that contextual information influences object identification in terms of relationships of objects to settings in which they are likely to be found which is built up through specific world knowledge based on past experience.

The purpose of the present study was to test for context effects by using drawings of integrated pictorial stimuli where a target object was embedded within each contextual background setting. It was assumed that people encode drawings of scenes much as they do real scenes and that the
types of information that are important to understanding and memory are the same for both. The Tulving (1972) verbal paradigm was utilized in attempt to expand the findings from verbal to pictorial stimuli, and from facial portraits to integrated scenes.

A second purpose of this study was to evaluate developmental changes in context effects as an organizational encoding process and retrieval strategy with second and sixth grade school children and adults. Research suggests that developmental differences in recognition memory for pictures reflects age differences in processing strategies rather than age differences in the amount of information which can be processed at different stages of development (Hoffman & Dick, 1976; Scarborough, 1977).

Mackworth and Bruner (1970) examined young children's ability to employ an effective search strategy in analyzing pictures. They tested children's ability to detect fine features by close inspection, and at the same time scan to test peripheral items for possible relevance to the integrated field. Subjects viewed a complete picture while their eye tracks were recorded. Children averaged tracks of only two-thirds the length of those made by adults. The interpretation of this result is that children became fixated on details, whereas adults more systematically scanned central aspects of the pictures. The 6 year old children consequently could not examine details centrally and simultaneously.
monitor the peripheral field for stimulus candidates for closer inspection. Also, Zinchenko, Chzhi-Tsin and Tarkanov (1963) found that for children between 3 and 6 years old, the number of eye movements increased with age during an initial familiarization with an unfamiliar simple figure. But the same picture, once familiar, produced fewer eye movements in older than in younger children. This suggests increased efficiency in information processing with age.

To test the development of children's visual exploration, Elkind (1975) constructed the Picture Exploration Test. The test consisted of two sets of cards on which pictures of familiar objects (cat, ice-cream cone, etc.) were pasted. On one set of cards, pictures were pasted in a triangular pattern for an ordered array. The other card set had pictures pasted in an irregular fashion so there was no suggestion of rows or columns, hence this presented a disordered array. With the disordered array, children just beginning school showed no systematic pattern for organization as they made errors of commission (naming some figures twice) and omission (failure to name some figures at all). Eight year old children made no such errors and named all figures correctly. In naming figures, eight year olds tended to start at the top left corner and name figures left to right and from top to bottom. The younger children showed no such systematic naming pattern.

Results on these types of tasks demanding center and
Peripheral scanning and organizational ability suggest that young children have difficulty analyzing a compound stimulus. However, a major limitation of many studies (Elkind, 1975; Druker & Hagan, 1969; and Hagan, 1970) with respect to the issue of concern in the present investigation is that the stimulus elements were not presented as integrated pictures but as disordered arrays and perhaps not even identifiable as a functional class.

Studies of the interrelationship between peripheral and central scanning could be more specifically analyzed if children were compared to adults under the proposed condition of integrated elements. With integrated pictures, common objects are presented such that there are meaningful inter-relationships among the components of each picture. Pictured objects conform to real world scenes with spacial location, size, and orientation relationships highly probable in terms of past experience. A child would more naturally view an integrated stimulus (scene) as a single unit and find it a more demanding task to separate the elements.

In the present study, context effects in picture recognition memory were examined with integrated picture stimuli across second and sixth grade school children and adults. The appropriateness of central figures to their contextual settings was varied. It was hypothesized that regardless of the appropriateness of the context at presentation, items will be better recognized if the context conditions at
encoding are the same as the context conditions of retrieval.

Secondly, due to apparent differences in visual processing strategies between adults and children, recognition was predicted to increase with age. In addition, it was predicted that the appropriateness of the context would have less effect on central item recognition with younger subjects due to children's inability to perceive both isolated parts and integrated wholes.
METHOD

Subjects and Design

Thirty second graders, thirty sixth graders, and thirty adults participated in the study. Second and sixth grade subjects were randomly selected from Morgan Elementary School in Rialto, California. Adult subjects were undergraduate volunteers from California State College at San Bernardino, California. Within each age group an equal number of male and female subjects were randomly assigned to one of two orders of presentation. The experiment utilized a factorial design with between subject variables of age of subject and two orders of presentation per age group. Within subject variables were 3 forms of presenting the stimulus pictures crossed with 4 types of test items. The dependent variable was percent correct on central item recognition.

Materials

A total of 108 black and white 35-mm slides were made from pen and ink sketches. Thirty-six central items were embedded in one of three different contextual backgrounds: (1) appropriate context—the central item and background were likely to occur together in terms of past experience, (2) no context—the central item was presented alone, and (3) inappropriate context—the central item and context were
randomly paired and thus were not likely to occur together in terms of real world experience. The study set consisted of 36 slides of which 12 were items in appropriate contexts, 12 were central items alone, and 12 were items randomly matched with inappropriate contexts. Each central item and each contextual background appeared only once in the presentation phase. An example of one central item in each of the 3 types of contextual backgrounds is provided in Figure 1.

The test set contained slides of the 36 study pictures plus 36 new distractor pictures. The manner in which the three presentation context conditions were combined with the four text context conditions is presented in Table 1. As can be seen in the table, old central items were paired with the same context they had been paired with during study in the 36 test slides indicated along the three diagonal cells. In addition, target items which originally appeared in appropriate contexts for study appeared alone and in inappropriate contexts for test. Central items which appeared in inappropriate contexts for study, appeared in appropriate contexts and no context for test. Items which had appeared in no context during study appeared in appropriate contexts and in inappropriate contexts for test. As a control, new items not previously seen during study, appeared in appropriate old contexts, alone, and in inappropriate old contexts. In the new changed test item conditions, the context was always one previously seen at presentation.
Figure 1. A-Central item appropriate context; B-Central item no context; C-Central item inappropriate context.
## TABLE 1

Percent Correct Recognition Responses Averaged Across Subjects for Each Context Condition

<table>
<thead>
<tr>
<th>Test Context</th>
<th>Encoding Context</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Appropriate Context</td>
<td>No Context</td>
<td>Inappropriate Context</td>
<td></td>
</tr>
<tr>
<td>Old Central Item</td>
<td>91 (N = 12)</td>
<td>64 (N = 4)</td>
<td>54 (N = 4)</td>
<td></td>
</tr>
<tr>
<td>Appropriate Context</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old Central Item</td>
<td>79 (N = 4)</td>
<td>93 (N = 4)</td>
<td>78 (N = 4)</td>
<td></td>
</tr>
<tr>
<td>No Context</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old Central Item</td>
<td>70 (N = 4)</td>
<td>62 (N = 4)</td>
<td>85 (N = 4)</td>
<td></td>
</tr>
<tr>
<td>Inappropriate Context</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Central Item</td>
<td>78 (N = 4)</td>
<td>88 (N = 4)</td>
<td>76 (N = 4)</td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Maximum score 100

Numbers in parenthesis indicate the number of pictures each subject viewed in each context condition of test.
PROCEDURE

Subjects were tested individually using slides projected by a Kodak carousel slide projector. Each subject was seated at a table with a rear projection screen directly in front of them at a distance of 70 cm. The experimenter was seated to the left of the subject to operate the slide carousel. Subjects were instructed before training that one picture at a time would be presented and they were to look carefully at each picture noting both the individual objects and the whole picture. During training, 36 slides were presented for 5 sec each. All subjects viewed one randomized series of slides at presentation with no more than two slides from each condition appearing consecutively. Following study, subjects were given an intervening maze tracing task for 5 minutes.

At the time of test, subjects were told they would again see pictures one at a time. Some pictures would be the same pictures they had seen earlier and some pictures would be new or different. Subjects were instructed to look carefully at each picture and the experimenter asked two questions. The first question was if they had seen the central item before, and for each slide the central item was pointed out by the experimenter. If the item was identified by the
subject as old then the subject was asked if when they saw the figure before had it been in the "same" background context in which it presently appeared or was the context now "different". However, because subjects often misunderstood this second question this data was not analyzed in study. The experimenter recorded the responses on answer sheets for each subject and controlled presentation by only permitting enough time for subjects to view the slide and immediately respond to central figure recognition and whole picture recognition. Test slides were shown in two random orders of presentation per age group and no more than 2 slides from each condition appeared consecutively.
RESULTS

The dependent variable, in this study, was percent correct recognition in each condition of presentation and test. The task of the subjects was to correctly recognize the central item in each picture. The rejection region for all analyses was $p < .05$.

An analysis of variance was carried out on the percent correct data. The analysis indicated significant main effects for type of test context, $F(3,252) = 14.31$, $MS_e = .079$. As can be seen in Table 1, the central item was most accurately recognized in the no context test condition, followed by the new item condition, then the inappropriate context condition, and recognition was least accurate in the appropriate context condition. Type of presentation context was also significant, $F(2,168) = 11.92$, $MS_e = .028$ in the direction that recognition was most accurate in the appropriate context condition. Recognition accuracy did not significantly change with age or order.

Several significant interactions were obtained. The interaction of type of test and presentation context was significant, $F(6,504) = 46.55$, $MS_e = 1.72$. As can be seen in Table 1, items and contexts presented together during study and again paired for test were better recognized than
items appearing in changed contexts for test. Also, the interaction between age level and type of test was significant, $F(6, 252) = 2.87$, $MS_e = .227$. There was no systematic pattern of the changing effects of test on recognition at different grades. The interaction between type of presentation context and age level was significant, $F(4, 168) = 3.43$, $MS_e = .954$, with second and sixth graders performing better on appropriate context conditions and adults on no context. All three age groups demonstrated poorest performance on the inappropriate context condition. In addition, there was a significant second order interaction of type of presentation context with type of test context and age, $F(12, 12) = 3.42$, $MS_e = .127$. The magnitude but not the direction of the test by presentation interaction changed with age.

Encoding specificity was more specifically tested by comparing mean recognition accuracy in conditions in which old items were presented for test in old vs. new contexts. Scheffe' comparisons were performed to compare the recognition accuracy on old items in old vs. new contexts. Averaging across the three age groups, all items were more accurately recognized in the context in which they were originally presented regardless of the appropriateness of the item and contextual pairings, ($F = 57.84$). The comparison was also significant for the second grade ($F = 32.65$), the sixth grade ($F = 31.27$), and the adult samples ($F = 13.68$), tested separately.
DISCUSSION

The purpose of this study was to test the presence of context effects using integrated pictorial stimuli where target objects were embedded within contextual settings. The context effects were examined by looking at changed vs. unchanged pairings of central object and surrounding context between study and test. In all cases, regardless of the appropriateness of the presentation context, the central object was better recognized when tested in its original study context. This was predicted on the basis of the assumption underlying the principle of encoding specificity, "the target is encoded with respect to the context in which it is seen producing a trace which incorporates information from both the target and the context," (Thomson & Tulving, 1972). Recognition of a to-be-remembered item would accordingly depend upon its context at the time of test with recognition being higher if test context matched input context than if input context were altered.

The data support the hypothesis that regardless of the appropriateness of context at the time of presentation, items were better recognized at test if the context had been held constant from presentation to test. The critical interaction between type of presentation context and type of test context
was significant with subjects demonstrating strong decrements in recognition performance when the background context was changed between study and test. The type of test context by presentation context interaction was significant at each grade level.

In addition, there was a reliable main effect of encoding condition. Target items were better recognized when they had been presented in appropriate contexts, followed by items presented alone, with recognition accuracy lowest in the inappropriate presentation context condition. One interpretation of this outcome is based on levels of processing analysis. In the appropriate context presentation condition the pictures were more meaningful and thus could be more elaborately encoded at the time of presentation. In the no context presentation condition, the absence of a contextual background restricted the degree of elaborative encoding of the central item. Finally, in the inappropriate context condition, the degree of elaboration was inhibited due to the lack of compatibility between the central item and the background. The finding from previous research (Craik & Lockheart, 1972; Nelson, 1974) that elaborative encoding (or levels of processing) is positively related to recognition accuracy, could thus explain the significant effect of presentation in the present study.

In addition, there was a significant main effect of context at test with recognition performance highest in the
no context condition, followed by the new item condition, inappropriate context condition, and performance was poorest in the appropriate context condition. The high recognition accuracy for the new items (80.9%) simply suggests that subjects were able to accurately distinguish old from new central items, regardless of contextual manipulations of the background. The low recognition accuracy for old items tested in both appropriate and inappropriate contexts suggests that the background context at the time of test inhibited recognition accuracy of the central item. It was apparently more difficult to isolate the central item and make recognition judgements when the item was tested in a background context than when it was presented alone. The finding that items tested in an appropriate context were recognized less accurately than items tested in an inappropriate context further suggests that the more independently the item could be judged from the background, the more accurate central item judgements were. Items tested alone, with no background context were most accurately recognized. This pattern of results is interesting and consistent with previous research (Palmer, 1975) which supports the significant role of context in perception as well as memory. In the present study, the background context in which the central items were tested significantly affected recognition accuracy, even though the background details did not physically overlap the central item which was always in the same position on each presentation
and test picture.

It was hypothesized that if young children are unable to integrate both the center and periphery of the visual field due to perceptual centering on the dominant aspect of the stimuli, then recognition during test would not reflect encoding specificity for conditions in which items appeared within the same contextual settings for both study and test. Hence, recognition performance would not be enhanced for children by the reinstatement of cues at test that were present at study and there would be an increase in recognition accuracy with age. In this study, there was no main effect of age on recognition performance and encoding specificity was evidenced at all age levels. These results indicate that by age 7 children are capable of processing integrated pictorial stimuli and that they have already developed proficiency in wholistically encoding multifeature pictorial stimuli. In addition, context appears to be an important part of the organizational encoding strategy in that it automatically increased the likelihood that subjects will recognize the components of a stimulus together.

The second order interaction of type of presentation context with type of test context with age was significant. However, this was due to change in the magnitude but not the direction of the test by presentation interaction at each grade. Recognition accuracy for conditions in which central items appeared in different contexts from study to test
indicated that as age increased recognition of central items in distractor conditions became more accurate. Presumably, adults more easily separated the target from its context and recognized it as familiar (seen before) than did young children. One interpretation of this outcome is that the child's knowledge about a pictured stimulus must be separated from his/her ability to use the stored information as the basis for responding under specific task requirements like those in this experiment. Consequently, whereas young subjects recognized originally paired targets and contexts they appeared to have difficulty separating targets from contexts and retrieving stored information in cases where a target item appeared in a different context from study to test. This would indicate the organizational strategy at encoding inhibited flexibility of access to that stored information for young subjects.

An alternative explanation for children's lower recognition scores on items in changed contexts is offered by Brown and Campione (1972). In their study, preschool children adopted a very conservative criterion for terming an item as "old" or having been seen before as the retention interval increased. This was interpreted in terms of a response bias to respond "new" whenever the children were uncertain. In the present study, when central items appeared in changed contexts from presentation to test the element of uncertainty on item recognition was increased. Thus, it is possible that
the second graders tended to respond new under changed context conditions and consequently demonstrate poorer recognition performance than sixth graders and adults. However, given the children responded "old" the probability that they were correct remained around .95 in the Brown and Campione study which is only slightly higher than second graders performance on old items in this study (92%). Such a response bias could explain second graders performance in changed context conditions.

The results of this study demonstrate that one of the critical properties of both verbal and pictorial stimuli which effect recognition performance is the contexts in which the targets are presented and tested. In addition, as early as age 7, children are processing visual information in relation to the contextual settings in which targets appear. It must be pointed out though, our understanding of the manner in which visual information is encoded is not yet sufficient to draw comparisons between pictorial and verbal stimuli. Nevertheless, the results of this study suggest that information presented pictorially can be used to test the generality of principles generated with verbal material. Through such research more general theories of memory can be developed.
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