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In addition, Miriam Mintzer and I have collaborated on several projects concerned with surface form effects in recognition memory, in which surface form was manipulated by changes in the form (picture versus word) of test items compared to study items. This line of research has also culminated in a paper and conference presentation (Mintzer & Snodgrass, 1997; Mintzer, 1994). I reported on both these lines of research in a paper delivered to the 8th Conference of the European Society for Cognitive Psychology entitled "The Sensory Match Effect in Recognition Memory: Perceptual Fluency or Episodic Trace?" in September 1995.

A third line of research concerns variables which determine the speed and accuracy of picture naming. A paper published in *Behavior Research Methods, Instruments, and Computers* with Tanya Yuditsky describes item variables which account for picture naming performance, and we have carried out a variety of experiments exploring parameters of priming in picture naming.

Stimulus Similarity vs. Process Similarity in Picture Priming

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Table of Contents

Abstract

This grant has supported the research training of four graduate students (Miriam Mintzer, Tanya Yuditsky, Hikari Kinjo, and Jin Fan) and one undergraduate student (Yuliya Sheynkman) in the area of human experimental cognition. Its primary purpose has been to broaden the range of the parent grant, Facilitation and Interference in Identification of Pictures and Words, by exploring more intensively an unexpected finding from the parent research — namely, that both explicit memory (recognition) and implicit memory (fragment completion and picture naming) show identical effects of similarity between study and test forms of the picture stimuli. We have explored two areas of research connected with this question. In the first, we have explored the question of whether the similarity effects occur because of stimulus similarity or process similarity between the two sets of items. We have done this by varying whether the fragments presented at study and test are the same or not, and by whether the level of fragmentation between study and test is the same or not. This line of research has culminated in a paper published in *Memory & Cognition* (Snodgrass, Hirshman, & Fan).

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Stimulus Similarity vs. Process Similarity in Picture Priming

1. Research Objectives

The work described is concerned with performance in the two tasks of direct or explicit memory and indirect or implicit memory. In most of the experiments to be described, the study phases of the two paradigms are identical, and only the test phases differ. On the test phase of the direct memory task, subjects are asked to decide, via a recognition or cued recall test, whether they have seen a particular item (a word or picture) before. Some of the recognition or cued recall cues are derived from old items and some are derived from new items. This task tests memory for the study episode directly by asking the subject to think back to the study episode and access information from that episode. Thus in this task we are studying the explicit retrieval process. On the test phase of the indirect memory task, subjects are are asked to identify (i.e., name) a fragmented item (a word or picture). Some of the fragment cues are derived from old items and some are derived from new items. Although subjects are expected to successfully identify both old and new fragments, their degree of implicit learning in this task is measured by the superiority of old fragment identification over new fragment identification. This task tests memory for the study episode indirectly because subjects are not asked to think back to the study episode but rather are only asked to identify the test item. Thus in this task we are studying the implicit retrieval process.

2. Background

The history of research on implicit and explicit memory has emphasized their differences — most particularly the fact that they are often found to be dissociated across a variety of subject and task manipulations. For example, memory-impaired subject groups typically show less impairment on indirect than direct memory tests. More important for our present purposes, differences in the amount of conceptual processing at study (whether subjects are caused to think about the meaning of a word or only about its physical form) have very large differences on explicit memory performance but minimal differences on implicit memory performance. This last dissociation has often been accounted for by the difference between data-driven vs. conceptually-driven processing (Jacoby, 1983; Roediger,1990). According to this distinction, success on explicit tests such as recognition and recall depends upon conceptual processing at study — upon having stored the meaning of the studied item, whereas success on implicit tests such as perceptual identification and fragment completion depends upon data-driven processing at study — upon having stored the surface form of the studied item. This analysis fits in well with prevailing views of recognition and recall as depending upon memory for gist or meaning rather than memory for surface form. For example, previous research has shown that switching between verbal and pictorial forms of an item between its study and test has minimal effects on recognition memory performance but large effects on fragment completion performance. That is, subjects are just as able to say that a studied picture was seen before when it is tested as a word as at a picture, even though they have good memory for the original form of the item at study. (Snodgrass & McClure, 1975). In contrast, subjects show almost no cross-form transfer in a fragment completion test. That is, although they can identify fragmented pictures studied as pictures better than unstudied pictures at test, their performance on studied words tested as pictures is almost at the level of new pictures (and vice versa) (Weldon & Roediger, 1987). One can hardly imagine a more profound surface change than that between the picture and word forms of a concept, yet this profound change apparently has very little or no effect on recognition memory.

This distinction between the two types of test in terms of their dependence upon conceptual as opposed to surface characteristics has, however, recently been challenged. Many investigators have reported conceptual processing effects on the implicit task of stem and fragment completion, and many others have reported sensory match effects (better recognition memory for test items which maintain the same surface form as the study item) on the explicit task of recognition memory. In our laboratory we have shown very subtle stimulus similarity effects on recognition memory (Snodgrass & Hirshman, 1994a). Because the results reported in Snodgrass and Hirshman formed the centerpiece of the reported research, we take a moment here to describe them.

The Snodgrass and Hirshman paper reported the results of four experiments which compared the effect of picture fragmentation level at study on performance across a variety of implicit and explicit memory tests. Snodgrass and Feenan (1990) found an inverted U shaped function between study fragmentation level and the amount of priming in picture fragment completion. In the Snodgrass and Hirshman paper, we asked whether we would observe the same inverted U shaped function in other implicit tests and in the explicit test of recognition memory. Consistent with the Snodgrass and Feenan results, a moderately fragmented study picture produced the most learning on the implicit memory task of picture fragment completion and speeded picture identification. Contrary to the Snodgrass and Feenan results, however, an intact study picture produced the most learning on the implicit memory task of naming intact pictures. These results suggested that performance on two implicit memory tasks can be dissociated by differences in fragmentation levels between the study and test forms of a stimulus. The best performance is observed when study and test fragmentation levels are most similar. More surprisingly, parallel effects were observed in recognition memory. Recognition memory was best when fragmentation levels of the study and test pictures matched. This result was surprising because, as noted above, recognition memory is generally assumed to be conceptually-driven rather than data-driven.

It is clear from the above that similarity between study and test pictures is crucial for determining optimum performance in both implicit and explicit tests. But what is the nature of this similarity? One possibility is that the similarity resides in the visual similarity of the study and test stimuli. These are most similar when the study and test fragmentation levels are identical or almost identical, and most different when the study and test fragmentation levels are most different. A second possibility is that the similarity resides in the similarity of processing applied to study and test stimuli of the same fragmentation level. When a moderately fragmented item is presented at study subjects must apply the process of perceptual closure to it to complete it. When the same moderately fragmented stimulus is presented at test, the same perceptual closure will be experienced, and this specific experience of perceptual closure to this item will reinvoke the study experience and lead to more effective or faster identification, if the task is implicit, or more accurate and faster recognition of oldness, if the task is explicit. This process explanation is closely related to the transfer-appropriate-processing hypothesis first proposed by Morris, Bransford, and Franks (1977) for recognition memory performance, and later adopted by Roediger and his colleagues (see Roediger, 1990) to account for performance on implicit memory tasks.

The reason that the process explanation is a theoretically viable argument for recognition memory in this situation is that different processes at study are assumed to be invoked by different fragmentation levels. Is there some way to distinguish process similarity from stimulus similarity? On the basis of previous research, we might reject the stimulus similarity explanation for recognition memory because of the minimal effects observed of cross-form changes between study and test. However, most cross-form recognition memory experiments have used an intentional study task, in which subjects were simply instructed to study these pictures and words for a subsequent memory test. Thus, subjects in these experiments were probably focused on the meaning, not the surface form, of the study items. In contrast, in the Snodgrass and Hirshman studies, the subjects' encoding task was to identify the pictures, and so subjects were focused on the surface characteristics of the pictures in the difficult (fragmented) conditions. Thus previous research does not seem to provide a clear answer to our question, and so the proposed research was designed to decide between the two similarity hypotheses — stimulus vs. process.

3. Sensory Matching in Implicit and Explicit Memory

In a series of experiments completed in 1995 (Snodgrass, Hirshman, & Fan, 1996), we used both fragment completion and recognition memory tests, and manipulated two variables: (a) the degree to which the study and test pictures contain the same percentage of pixel blocks (i.e., the fragmentation level), and (b) the degree to which the study and test pictures contain the same pixel blocks (i.e., the degree of overlap between pixel blocks).The overlap variable is particularly crucial in distinguishing between stimulus similarity and processing similarity hypotheses. Consider a case where there is 0% overlap between study and test fragments but that the level of fragmentation is the same (e.g., 50%). The stimulus similarity between study and test fragments is low because they have no pictorial elements in common, but the process similarity is high because in both cases the subjects have to perceptually complete the missing elements of the picture. If there were no effect of overlap between the two sets of fragments, this would be strong support for process similarity.

In our experiments with picture fragment completion, we found no decrement in priming when subjects studied a fragmented picture and then were tested with a fragment having the same proportion of pixel blocks with no overlap between study and test (complementary fragments) compared to a test with exactly the same fragments (matching fragments). This would seem to rule out a stimulus similarity explanation in favor of a process similarity explanation. Biederman and Cooper (1991) have reported a similar lack of specificity of priming, but only for fragmented pictures whose geons (object parts) were still retrievable. In contrast to the lack of effect for picture fragment completion, the matching/complementary variable had a large effect on recognition memory — matching fragments were recognized as old better than complementary fragments. An experiment which combined the two responses (subjects first attempted to identify a test fragment and then made an old/new judgment) revealed that the major advantage in recognition memory for matching fragments occurred when they were not identified. Unidentified matching fragments were recognized as old at greater than chance levels, whereas unidentified complementary fragments were not.

The preceding results suggest that, contrary to common belief, recognition memory appears to be *more* sensitive to surface effects than fragment completion. However, one could argue against this interpretation of the results. It is clear that recognition memory can be based on either conceptual or surface information; people can, after all, recognize as old something for which they have no name, such as a face of a stranger or a nonsense figure. Thus success in recognition memory can occur in either or both of two ways: by recognition of the concept itself, and by recognition of its surface form. However, in fragment completion, success can only occur one way: by identification of the concept by its name. Any sense of familiarity produced by matching fragments cannot help the subject to identify the picture, but can help the subject in making a recognition judgment. Thus, comparisons between explicit and implicit memory need to take into account the requirements of each task.

In order to determine whether these surprising results were the result of the selected implicit and explicit tasks (i.e., fragment identification and recognition memory), we next conducted a series of experiments which looked at a second implicit task — categorization of fragmented pictures into natural and man-made categories, and a second explicit task — cued recall using the same or different fragments at test as at study. Like fragment identification, categorization showed no sensory match effects whatsoever, even though one could presumably classify pictures into the two categories without naming them. In contrast, cued recall did show an effect of sensory matching. Accordingly, we have concluded that explicit memory benefits from sensory matching, and suffers from sensory mismatching. This, to us, suggests an important role in sensory memory images as retrieval cues in explicit memory, and also may suggest that this is exactly what is missing in elderly memory. We are in the process of writing this latest set of research findings up for publication (Fan & Snodgrass, The Sensory Match Effect in Explicit and Implicit Memory), and are also in the process of planning some research with elderly subjects to test our hypothesis.

4. The Sensory Match Effect in Recognition Memory

Snodgrass and Mintzer (1994) explored the sensory match effect in recognition memory (the fact that recognition memory tends to be better when the sensory characteristics of study and test items are the same) by presenting pictures and words at study and testing them for recognition in either the same or different form. Surface change cost was defined as the difference between recognition performance for same and different form items. We were particularly interested in determining the relationship between surface change cost and each of the two hypothesized components of recognition memory — familiarity or perceptual fluency, and retrieval. In particular, it seemed likely to us that surface change cost was caused by changes in familiarity rather than changes in retrieval efficiency. Across five experiments, we found that both pictures and word experienced approximately equal amounts of surface change cost, and that the degree of cost did not vary as a function of number of study exposures nor as a function of level of processing at study. Cost was eliminated by preexposing subjects to picture-word pairs and through inducing subjects to generate the alternate form of the stimulus at study. We concluded that cost is unlikely to be produced either solely by changes in familiarity or by changes in retrieval but is likely to be produced by a combination of both. While familiarity/perceptual fluency is certainly less for changed-form test items, Tulving's (1983) theory of encoding specificity would predict a decline in retrievability of the episode when anything about the study context of the item, including its form, was changed. A joint paper (Mintzer and Snodgrass) has been prepared for publication and is in the process of being reviewed.

5. Processes in Picture Naming

People have long speculated on the processes underlying the process of picture naming. Generally, picture naming is assumed to consist of at least three processes: a structural analysis of the visual features of the picture so as to construct a three-dimensional representation; access of the meaning of the picture; and access to the picture's name. In a recently published paper(Snodgrass & Yuditsky, 1996), we report the results of two experiments. In the first, voice-key naming times were collected and in the second keypress naming times were collected for 250 of the Snodgrass and Vanderwart pictures. The resulting naming times and correct naming rates were well predicted in multiple regression analyses by one or another measure of codability (name or concept agreement) and by age-of-acquisition ratings collected specifically for this study. Voice key responses appeared to be somewhat more sensitive indicators of naming difficulty, although keypress responses did remarkably well.

In a subsequent paper, which is being revised for publication (Yuditsky & Snodgrass), we used a short-term priming paradigm to investigate priming of speeded picture naming (Experiment 1) and identification of fragmented pictures (Experiment 2) and fragmented words (Experiment 3). Three types of primes — visual, semantic, and lexical — were used to selectively influence the three hypothetical processing stages involved in the tasks. Speeded picture naming was most affected by the lexical prime whereas both fragmented picture and fragmented word identification were most affected by the semantic prime, suggesting that access to the picture's name is the more difficult process in picture naming,while access to the item's meaning is the more difficult process in fragment identification. Several new priming paradigms are presently being used in our laboratory to investigate these processes in more detail. In addition, we are exploring priming of picture-naming by bilinguals in which either the name of the picture in the response language or the name of the picture in the second language is used as a prime.

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Cycowicz, Y.M., Friedman, D., Rothstein, M., & Snodgrass, J. G. (1997). Picture naming by young children: Norms for name agreement, familiarity, and visual complexity. *Journal of Experimental Child Psychology, 64,* 000-000.

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8. Conference Presentations resulting from this grant

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Snodgrass, J. G., & Sheynkman, Y. (1994). Second Language Vocabulary Learning: Conceptual Mediation vs. Word-to-Word Association. Paper presented at the third meeting of the Practical Memory Conference, College Park, Md., August, 1994.

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Fan, J. (1997). The sensory match effect in cued recall. Poster presented at the annual meeting of the Eastern Psychological Association, Washington, DC, April 1997.

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In addition, Miriam Mintzer and I have collaborated on several projects concerned with surface form effects in recognition memory, in which surface form was manipulated by changes in the form (picture versus word) of test items compared to study items. This line of research has also culminated in a paper and conference presentation (Mintzer & Snodgrass, 1997; Mintzer, 1994). I reported on both these lines of research in a paper delivered to the 8th Conference of the European Society for Cognitive Psychology entitled "The Sensory Match Effect in Recognition Memory: Perceptual Fluency or Episodic Trace?" in September 1995.

A third line of research concerns variables which determine the speed and accuracy of picture naming. A paper published in *Behavior Research Methods, Instruments, and Computers* with Tanya Yuditsky describes item variables which account for picture naming performance, and we have carried out a variety of experiments exploring parameters of priming in picture naming.

Stimulus Similarity vs. Process Similarity in Picture Priming

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Table of Contents

Abstract

This grant has supported the research training of four graduate students (Miriam Mintzer, Tanya Yuditsky, Hikari Kinjo, and Jin Fan) and one undergraduate student (Yuliya Sheynkman) in the area of human experimental cognition. Its primary purpose has been to broaden the range of the parent grant, Facilitation and Interference in Identification of Pictures and Words, by exploring more intensively an unexpected finding from the parent research — namely, that both explicit memory (recognition) and implicit memory (fragment completion and picture naming) show identical effects of similarity between study and test forms of the picture stimuli. We have explored two areas of research connected with this question. In the first, we have explored the question of whether the similarity effects occur because of stimulus similarity or process similarity between the two sets of items. We have done this by varying whether the fragments presented at study and test are the same or not, and by whether the level of fragmentation between study and test is the same or not. This line of research has culminated in a paper published in *Memory & Cognition* (Snodgrass, Hirshman, & Fan).

In addition, Miriam Mintzer and I have collaborated on several projects concerned with surface form effects in recognition memory, in which surface form was manipulated by changes in the form (picture versus word) of test items compared to study items. This line of research has also culminated in a paper and conference presentation (Mintzer & Snodgrass, 1997; Mintzer, 1994). I reported on both these lines of research in a paper delivered to the 8th Conference of the European Society for Cognitive Psychology entitled "The Sensory Match Effect in Recognition Memory: Perceptual Fluency or Episodic Trace?" in September 1995.

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Stimulus Similarity vs. Process Similarity in Picture Priming

1. Research Objectives

The work described is concerned with performance in the two tasks of direct or explicit memory and indirect or implicit memory. In most of the experiments to be described, the study phases of the two paradigms are identical, and only the test phases differ. On the test phase of the direct memory task, subjects are asked to decide, via a recognition or cued recall test, whether they have seen a particular item (a word or picture) before. Some of the recognition or cued recall cues are derived from old items and some are derived from new items. This task tests memory for the study episode directly by asking the subject to think back to the study episode and access information from that episode. Thus in this task we are studying the explicit retrieval process. On the test phase of the indirect memory task, subjects are are asked to identify (i.e., name) a fragmented item (a word or picture). Some of the fragment cues are derived from old items and some are derived from new items. Although subjects are expected to successfully identify both old and new fragments, their degree of implicit learning in this task is measured by the superiority of old fragment identification over new fragment identification. This task tests memory for the study episode indirectly because subjects are not asked to think back to the study episode but rather are only asked to identify the test item. Thus in this task we are studying the implicit retrieval process.

2. Background

The history of research on implicit and explicit memory has emphasized their differences — most particularly the fact that they are often found to be dissociated across a variety of subject and task manipulations. For example, memory-impaired subject groups typically show less impairment on indirect than direct memory tests. More important for our present purposes, differences in the amount of conceptual processing at study (whether subjects are caused to think about the meaning of a word or only about its physical form) have very large differences on explicit memory performance but minimal differences on implicit memory performance. This last dissociation has often been accounted for by the difference between data-driven vs. conceptually-driven processing (Jacoby, 1983; Roediger,1990). According to this distinction, success on explicit tests such as recognition and recall depends upon conceptual processing at study — upon having stored the meaning of the studied item, whereas success on implicit tests such as perceptual identification and fragment completion depends upon data-driven processing at study — upon having stored the surface form of the studied item. This analysis fits in well with prevailing views of recognition and recall as depending upon memory for gist or meaning rather than memory for surface form. For example, previous research has shown that switching between verbal and pictorial forms of an item between its study and test has minimal effects on recognition memory performance but large effects on fragment completion performance. That is, subjects are just as able to say that a studied picture was seen before when it is tested as a word as at a picture, even though they have good memory for the original form of the item at study. (Snodgrass & McClure, 1975). In contrast, subjects show almost no cross-form transfer in a fragment completion test. That is, although they can identify fragmented pictures studied as pictures better than unstudied pictures at test, their performance on studied words tested as pictures is almost at the level of new pictures (and vice versa) (Weldon & Roediger, 1987). One can hardly imagine a more profound surface change than that between the picture and word forms of a concept, yet this profound change apparently has very little or no effect on recognition memory.

This distinction between the two types of test in terms of their dependence upon conceptual as opposed to surface characteristics has, however, recently been challenged. Many investigators have reported conceptual processing effects on the implicit task of stem and fragment completion, and many others have reported sensory match effects (better recognition memory for test items which maintain the same surface form as the study item) on the explicit task of recognition memory. In our laboratory we have shown very subtle stimulus similarity effects on recognition memory (Snodgrass & Hirshman, 1994a). Because the results reported in Snodgrass and Hirshman formed the centerpiece of the reported research, we take a moment here to describe them.

The Snodgrass and Hirshman paper reported the results of four experiments which compared the effect of picture fragmentation level at study on performance across a variety of implicit and explicit memory tests. Snodgrass and Feenan (1990) found an inverted U shaped function between study fragmentation level and the amount of priming in picture fragment completion. In the Snodgrass and Hirshman paper, we asked whether we would observe the same inverted U shaped function in other implicit tests and in the explicit test of recognition memory. Consistent with the Snodgrass and Feenan results, a moderately fragmented study picture produced the most learning on the implicit memory task of picture fragment completion and speeded picture identification. Contrary to the Snodgrass and Feenan results, however, an intact study picture produced the most learning on the implicit memory task of naming intact pictures. These results suggested that performance on two implicit memory tasks can be dissociated by differences in fragmentation levels between the study and test forms of a stimulus. The best performance is observed when study and test fragmentation levels are most similar. More surprisingly, parallel effects were observed in recognition memory. Recognition memory was best when fragmentation levels of the study and test pictures matched. This result was surprising because, as noted above, recognition memory is generally assumed to be conceptually-driven rather than data-driven.

It is clear from the above that similarity between study and test pictures is crucial for determining optimum performance in both implicit and explicit tests. But what is the nature of this similarity? One possibility is that the similarity resides in the visual similarity of the study and test stimuli. These are most similar when the study and test fragmentation levels are identical or almost identical, and most different when the study and test fragmentation levels are most different. A second possibility is that the similarity resides in the similarity of processing applied to study and test stimuli of the same fragmentation level. When a moderately fragmented item is presented at study subjects must apply the process of perceptual closure to it to complete it. When the same moderately fragmented stimulus is presented at test, the same perceptual closure will be experienced, and this specific experience of perceptual closure to this item will reinvoke the study experience and lead to more effective or faster identification, if the task is implicit, or more accurate and faster recognition of oldness, if the task is explicit. This process explanation is closely related to the transfer-appropriate-processing hypothesis first proposed by Morris, Bransford, and Franks (1977) for recognition memory performance, and later adopted by Roediger and his colleagues (see Roediger, 1990) to account for performance on implicit memory tasks.

The reason that the process explanation is a theoretically viable argument for recognition memory in this situation is that different processes at study are assumed to be invoked by different fragmentation levels. Is there some way to distinguish process similarity from stimulus similarity? On the basis of previous research, we might reject the stimulus similarity explanation for recognition memory because of the minimal effects observed of cross-form changes between study and test. However, most cross-form recognition memory experiments have used an intentional study task, in which subjects were simply instructed to study these pictures and words for a subsequent memory test. Thus, subjects in these experiments were probably focused on the meaning, not the surface form, of the study items. In contrast, in the Snodgrass and Hirshman studies, the subjects' encoding task was to identify the pictures, and so subjects were focused on the surface characteristics of the pictures in the difficult (fragmented) conditions. Thus previous research does not seem to provide a clear answer to our question, and so the proposed research was designed to decide between the two similarity hypotheses — stimulus vs. process.

3. Sensory Matching in Implicit and Explicit Memory

In a series of experiments completed in 1995 (Snodgrass, Hirshman, & Fan, 1996), we used both fragment completion and recognition memory tests, and manipulated two variables: (a) the degree to which the study and test pictures contain the same percentage of pixel blocks (i.e., the fragmentation level), and (b) the degree to which the study and test pictures contain the same pixel blocks (i.e., the degree of overlap between pixel blocks).The overlap variable is particularly crucial in distinguishing between stimulus similarity and processing similarity hypotheses. Consider a case where there is 0% overlap between study and test fragments but that the level of fragmentation is the same (e.g., 50%). The stimulus similarity between study and test fragments is low because they have no pictorial elements in common, but the process similarity is high because in both cases the subjects have to perceptually complete the missing elements of the picture. If there were no effect of overlap between the two sets of fragments, this would be strong support for process similarity.

In our experiments with picture fragment completion, we found no decrement in priming when subjects studied a fragmented picture and then were tested with a fragment having the same proportion of pixel blocks with no overlap between study and test (complementary fragments) compared to a test with exactly the same fragments (matching fragments). This would seem to rule out a stimulus similarity explanation in favor of a process similarity explanation. Biederman and Cooper (1991) have reported a similar lack of specificity of priming, but only for fragmented pictures whose geons (object parts) were still retrievable. In contrast to the lack of effect for picture fragment completion, the matching/complementary variable had a large effect on recognition memory — matching fragments were recognized as old better than complementary fragments. An experiment which combined the two responses (subjects first attempted to identify a test fragment and then made an old/new judgment) revealed that the major advantage in recognition memory for matching fragments occurred when they were not identified. Unidentified matching fragments were recognized as old at greater than chance levels, whereas unidentified complementary fragments were not.

The preceding results suggest that, contrary to common belief, recognition memory appears to be *more* sensitive to surface effects than fragment completion. However, one could argue against this interpretation of the results. It is clear that recognition memory can be based on either conceptual or surface information; people can, after all, recognize as old something for which they have no name, such as a face of a stranger or a nonsense figure. Thus success in recognition memory can occur in either or both of two ways: by recognition of the concept itself, and by recognition of its surface form. However, in fragment completion, success can only occur one way: by identification of the concept by its name. Any sense of familiarity produced by matching fragments cannot help the subject to identify the picture, but can help the subject in making a recognition judgment. Thus, comparisons between explicit and implicit memory need to take into account the requirements of each task.

In order to determine whether these surprising results were the result of the selected implicit and explicit tasks (i.e., fragment identification and recognition memory), we next conducted a series of experiments which looked at a second implicit task — categorization of fragmented pictures into natural and man-made categories, and a second explicit task — cued recall using the same or different fragments at test as at study. Like fragment identification, categorization showed no sensory match effects whatsoever, even though one could presumably classify pictures into the two categories without naming them. In contrast, cued recall did show an effect of sensory matching. Accordingly, we have concluded that explicit memory benefits from sensory matching, and suffers from sensory mismatching. This, to us, suggests an important role in sensory memory images as retrieval cues in explicit memory, and also may suggest that this is exactly what is missing in elderly memory. We are in the process of writing this latest set of research findings up for publication (Fan & Snodgrass, The Sensory Match Effect in Explicit and Implicit Memory), and are also in the process of planning some research with elderly subjects to test our hypothesis.

4. The Sensory Match Effect in Recognition Memory

Snodgrass and Mintzer (1994) explored the sensory match effect in recognition memory (the fact that recognition memory tends to be better when the sensory characteristics of study and test items are the same) by presenting pictures and words at study and testing them for recognition in either the same or different form. Surface change cost was defined as the difference between recognition performance for same and different form items. We were particularly interested in determining the relationship between surface change cost and each of the two hypothesized components of recognition memory — familiarity or perceptual fluency, and retrieval. In particular, it seemed likely to us that surface change cost was caused by changes in familiarity rather than changes in retrieval efficiency. Across five experiments, we found that both pictures and word experienced approximately equal amounts of surface change cost, and that the degree of cost did not vary as a function of number of study exposures nor as a function of level of processing at study. Cost was eliminated by preexposing subjects to picture-word pairs and through inducing subjects to generate the alternate form of the stimulus at study. We concluded that cost is unlikely to be produced either solely by changes in familiarity or by changes in retrieval but is likely to be produced by a combination of both. While familiarity/perceptual fluency is certainly less for changed-form test items, Tulving's (1983) theory of encoding specificity would predict a decline in retrievability of the episode when anything about the study context of the item, including its form, was changed. A joint paper (Mintzer and Snodgrass) has been prepared for publication and is in the process of being reviewed.

5. Processes in Picture Naming

People have long speculated on the processes underlying the process of picture naming. Generally, picture naming is assumed to consist of at least three processes: a structural analysis of the visual features of the picture so as to construct a three-dimensional representation; access of the meaning of the picture; and access to the picture's name. In a recently published paper(Snodgrass & Yuditsky, 1996), we report the results of two experiments. In the first, voice-key naming times were collected and in the second keypress naming times were collected for 250 of the Snodgrass and Vanderwart pictures. The resulting naming times and correct naming rates were well predicted in multiple regression analyses by one or another measure of codability (name or concept agreement) and by age-of-acquisition ratings collected specifically for this study. Voice key responses appeared to be somewhat more sensitive indicators of naming difficulty, although keypress responses did remarkably well.

In a subsequent paper, which is being revised for publication (Yuditsky & Snodgrass), we used a short-term priming paradigm to investigate priming of speeded picture naming (Experiment 1) and identification of fragmented pictures (Experiment 2) and fragmented words (Experiment 3). Three types of primes — visual, semantic, and lexical — were used to selectively influence the three hypothetical processing stages involved in the tasks. Speeded picture naming was most affected by the lexical prime whereas both fragmented picture and fragmented word identification were most affected by the semantic prime, suggesting that access to the picture's name is the more difficult process in picture naming,while access to the item's meaning is the more difficult process in fragment identification. Several new priming paradigms are presently being used in our laboratory to investigate these processes in more detail. In addition, we are exploring priming of picture-naming by bilinguals in which either the name of the picture in the response language or the name of the picture in the second language is used as a prime.

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8. Conference Presentations resulting from this grant

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Snodgrass, J. G., & Sheynkman, Y. (1994). Second Language Vocabulary Learning: Conceptual Mediation vs. Word-to-Word Association. Paper presented at the third meeting of the Practical Memory Conference, College Park, Md., August, 1994.

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Kinjo, H. (1995). A source judgment task on fragmented pictures. Paper presented at the annual meeting of the Eastern Psychological Association, Boston, MA, April 1995 .

Mintzer, M. (1995). The cost of surface change in recognition memory. Paper presented at the annual meeting of the Eastern Psychological Association, Boston, MA , April 1995 .

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Fan, J. (1997). The sensory match effect in cued recall. Poster presented at the annual meeting of the Eastern Psychological Association, Washington, DC, April 1997.

9. Names of participating professionals

1. Elliot Hirshman, Associate Professor, Department of Psychology, University of North Carolina at Chapel Hill (co-author on one or more papers, collaborator)

2. Chun Luo, Assistant Professor, Wesleyan University, former graduate student, doctoral program, Department of Psychology, New York University (collaborator, co-author on one or more papers).

3. Miriam Mintzer, Postdoctoral Fellow, Johns Hopkins Medical School, former graduate student, doctoral program, Department of Psychology, New York University (collaborator, research

assistant, co-author on one or more papers).

4. Tanya Yuditsky, graduate student, doctoral program, Department of Psychology, New York University (collaborator, research assistant, co-author on one or more papers).

5. Hikari Kinjo, graduate student, doctoral program, Department of Psychology, New York University (collaborator, research assistant, co-author on one or more papers).

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