Proceedings of the Ninth Annual Meeting of the International Society for Psychophysics

UNED
Palma de Mallorca, SPAIN
October 21-24, 1993

FECHNER DAY 93

Editors

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Madrid, SPAIN

ENCODING SPECIFICITY IN PERCEPTUAL PRIMING

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Abstract

Priming on perceptual implicit memory tests (those measuring incidental retrieval) is quite resistant to factors (such as brain damage) that produce large effects on standard explicit tests such as recall or recognition, which measure intentional recollection. We argue that most implicit memory tests reflect a form of perceptual learning quite distinct from types of memory thought to underlie performance on explicit tests. In particular, priming on perceptual implicit tests is greatly affected by the manipulation of physical features of stimuli that have either no effect or opposite effects on explicit tests. Additionally, whereas conceptual manipulations (such as elaboration of meaning) have little or no effect on perceptual priming, manipulations of perceptual variables such as imagery do affect priming. We present results showing that perceptual and imaginal factors produce highly specific effects on transfer or priming.

In the past 15 years, researchers in cognitive psychology have been intensively investigating a new class of test, called implicit memory tests (Graf & Schacter, 1985). Implicit tests differ from explicit tests, which have been the standard measures of memory used by psychologists for a hundred years, in that implicit tests measure incidental (rather than intentional) retrieval. On both explicit and implicit tests, subjects are exposed to material and are later tested on that material. On explicit tests, subjects are asked to recall or recognize the items presented earlier, invoking intentional recollection. On implicit tests, the measure of retention occurs indirectly, by transferring the prior experience to ostensibly unrelated ongoing behavior. Retrieval of past experience is incidental to the task at hand.

The question of interest is how the prior experiences transfer to, or prime, the later behaviors when subjects are not intentionally recollecting the prior events. In typical paradigms, subjects are exposed to a list of words or pictures and then, at some later point, given the implicit test in which they are shown fragmented forms of words or pictures and asked to identify them as well as possible. The emphasis is simply on identifying the words or pictures, not on trying to recollect items from the previous study list. The finding is that prior study of words or pictures facilitates later naming of the fragmented forms, relative to a control condition in which the same words or pictures were not presented at study. This priming effect is interesting because it can be dissociated from performance on explicit tests, as both a function of subject variables and of variables under experimental control. We consider an example of each case.

Dissociations between explicit and implicit tests

The current fascination with implicit memory tests originated in neuropsychological work. Damage to certain parts of the brain causes profound losses on standard memory

tests (Squire, 1987). Patients suffering from such amnesia often fail to consciously recollect virtually any new information, including their doctor's name despite hundreds of meetings, and current events despite watching television. However, many experiments have now been conducted showing that even severely amnesic patients behave normally on perceptual priming tests. That is, when shown a list of words or pictures that they later fail to recollect, they nonetheless show intact priming in naming fragmented forms of the words or pictures. This finding holds true on some half dozen implicit memory tests (Shimamura, 1986). In addition to being preserved in amnesic patients, priming on such tests is also little affected by other subject variables such as age (old people show intact priming relative to young, despite worse performance on explicit tests; see Parkin, 1993) and depression (chronically depressed patients show relatively intact priming, but poor performance on explicit tests; Denny & Hunt, 1992).

Priming on implicit tests can also be dissociated from explicit measures by variables under experimental control. Perhaps the most-studied example of this is the effect of levels of processing: Subjects study words with instructions to perform different tasks on each, such as checking the orthography (Is the word in uppercase letters?), judging the phonology (Does the word rhyme with chair?), or making a judgment based on the word's meaning (Does the word refer to an animal?). This manipulation has a dramatic effect on explicit tests, with meaningful encoding of the word producing much better recall or recognition than orthographic or phonological encoding. However, this variable seems to have very little and often no effect on priming on implicit memory tests. That is, priming is equivalent following all three manipulations (Jacoby & Dallas, 1981; Roediger, Weldon, Stadler, & Riegler, 1992). Roediger and McDermott (1993) review many variables that have different effects on performance on implicit and explicit tests.

How can we explain these differences between tests? Why should variables that affect performance on classic memory tests have such different effects on the implicit tests? One answer to this question is that standard implicit tests are tapping a form of perceptual memory quite unlike that normally reflected on explicit tests, which are more reliant on conceptual processing. Simply seeing the word is sufficient to obtain full-blown priming; there is no effect of level of processing because this variable does nothing to affect the basic perceptual operations used in perceiving the word. Roediger and Blaxton (1987) suggested that the standard implicit memory tests involving fragment completion relied on data-driven (bottom-up) processing. Tulving and Schacter (1990) have argued that learning on these tests reflects the operations of separate perceptual memory systems.

We consider here two lines of evidence that support these positions. The first is evidence that priming on these tests is greatly affected by manipulation of surface features. As an illustration of this point, we present data from several experiments in Table 1 (all reviewed in Roediger & McDermott, 1993). We consider six different conditions in which concepts were presented, but the means of presentation were different in each case. In every case, the criterial task was completing fragmented words (_ u s _ r o _ m) after various study manipulations. Experiments typically involve presentation of 50-100 items during the study phase, with the test consisting of fragments for twice that many. Thus, half of the fragments correspond to studied items; the other half represent nonstudied items. Items are counterbalanced over conditions. In the case of the first study condition in Table 1, subjects received conceptual cues and fragments and were instructed to generate the target items from these clues; in the second case, subjects read the words (visual presentation), and in the third case heard words (auditory presentation). In the last three cases subjects received roughly the same concept, but now in a quite different surface form. Either they saw a picture of the concept, read a synonym, or (for bilingual

subjects) they received a translation equivalent. In short, the interest is in priming on the same fragments following six different study conditions.

Table 1. Level of priming on word fragment completion as a function of study condition.

Study Manipulation	Test stimulus	Priming*
Fragment		
An edible fungus: _ u s _ r o _ m	_ u s _ r o _ m	.40
Visual Word mushroom	_ u s _ r o _ m	.23
Auditory Word "mushroom"	_ u s _ r o _ m	.13
Picture 	_ u s _ r o _ m	.04
Synonym toadstool	_ u s _ r o _ m	.02
Translation equivalent hongo	_ u s _ r o _ m	.05

* Priming: Studied-Nonstudied

In the far right column of Table 1 is the amount of priming (or enhancement of performance as a result of the study phase, relative to a baseline measure in which there was no relevant study phase) that was produced in completing the word fragments. The results are quite striking, with most priming occurring when subjects had actually deciphered the fragment during the study phase, and next most priming occurring when subjects had studied the visual word. When subjects had received the word auditorily in the study phase, there was significant priming, but it was much less than after visual presentation. Finally, in the last three conditions, in which subjects saw pictures, synonyms, or translation equivalents, there was essentially no priming. The results in Table 1 show the highly specific effects of study format on perceptual priming. The reader should bear in mind that, had explicit tests been used, the results would look quite different. For example, pictures typically produce better conscious recollection than do words on tests of recall or recognition. In addition, the fact that little or no priming occurred from the presentation of pictures, synonyms, or translation equivalents shows that these implicit memory tests are not contaminated by intentional retrieval processes; if subjects are so instructed, they are perfectly capable of remembering pictures, synonyms, and translation equivalents when given word fragment cues (Roediger et al., 1992). At the very least, they can do so much better when they have studied the items than when they have not (unlike the case on the implicit tests).

The second line of evidence supporting the notion that priming on these tests is perceptual in nature comes from manipulations of imagery. As discussed previously, many instructional manipulations have little or no effect on perceptual implicit tests. These include incidental versus intentional learning, variation in orienting task, and several others. However, if the tests are perceptual in nature, it should be the case that instructions to imagine relevant objects could affect performance; this hypothesis is based on theories positing an overlap between the neural mechanisms involved in imagery and perception (e.g., Finke, 1980; Farah, 1988). That is, if subjects are given a picture and told to produce a visual image of the word naming the picture, this imaginal processing may enhance priming on the word fragment completion test (relative to a condition in which subjects see the word under some other orienting task). Similarly, if the criterial test is naming fragmented pictures, there is generally little priming from prior study of words (Srinivas, 1993); however, if subjects are given the words and asked to form mental pictures of the words' referents, then priming should be increased. These general predictions have been found to be upheld in experimental data.

Several groups of researchers have shown that when subjects hear words and are told either to spell them or imagine what the word would look like if typed, priming increases on verbal implicit memory tests (Roediger & Blaxton, 1987). In recent work in the first author's laboratory, McDermott has conducted similar experiments with a picture-based test. In her test people tried to name severely fragmented pictures that were presented very briefly. Prior to doing so, however, they had been exposed either to words naming the pictures, or to intact pictorial forms. (Previous work had shown that considerable priming occurred from pictures to their fragmented forms, but not from words to the picture fragments). McDermott also employed a third condition: Subjects saw words but were told to form mental images of the words' referents. Her results, collapsed across several experiments, are shown below in Figure 1. As is apparent, she obtained little or no priming from words to naming picture fragments, but found sizeable priming from prior study of intact pictures to naming their fragmented forms (replicating Srinivas, 1993, among others). The interesting new finding was that when subjects studied words but were asked to form images of the words' referents, priming significantly increased and was about intermediate between the two other conditions. This is especially noteworthy because she made no effort to control the type of image that subjects formed (i.e., no steps were taken to ensure that the image formed would bear any resemblance to the picture whose fragmented form would later be shown).

In other experiments, McDermott showed that the imagery effect was highly specific to the form of the test. For example, forming images of pictures when given words increased priming on the picture fragment naming test, but not a word fragment completion test. Conversely, if subjects were given pictures and asked to form an image of the words that named the pictures, enhanced priming occurred on a word fragment completion test, but not on a picture fragment naming test. These results again show the specificity of perceptual priming. They also show that the implicit memory tests are not badly contaminated by intentional recollection. That is, if intentional recollection were responsible for the enhanced priming from images, then one would expect to find it on all tests used, not just ones with appropriate cues.

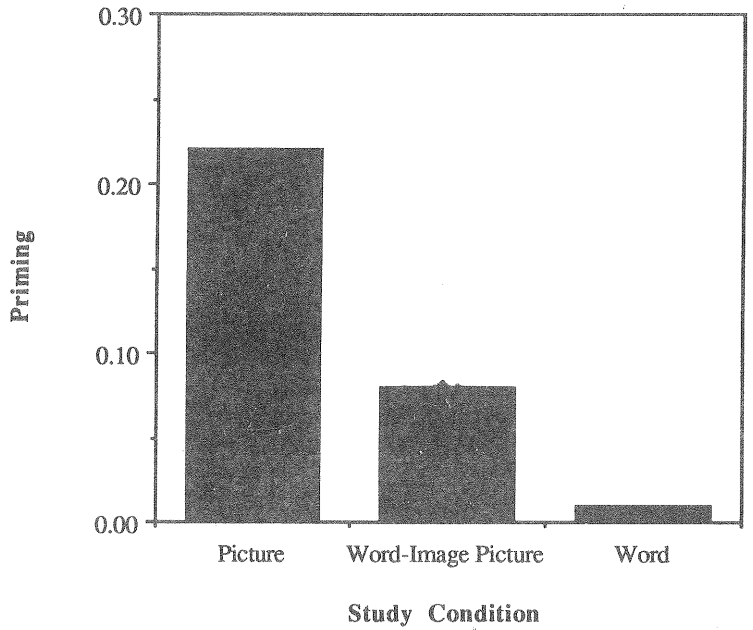

Figure 1. Priming on the Picture Fragment Identification Test as a function of study condition.

Conclusion

Implicit tests seem to reflect a form of memory quite different from that supporting performance on standard explicit tests; we have made the case that this type of memory is perceptual in nature. (There does seem to be a second type of implicit memory test, known as conceptual tests, that obeys different principles from those under consideration here). We have reviewed evidence showing that specificity of perceptual operations greatly affects performance on perceptual priming tests, and so do imaginal manipulations. Both sets of results are consistent with the idea that these implicit tests are supported by perceptual processes or perceptual memory systems unrelated to (or at least different from) those used to support conscious recollection.

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