Journal Title: The American journal of psychology

Volume: 103
Issue: 2
Month/Year: 1990
Pages: 229-242

Article Author: Smith, Steven

Article Title: Environmental context-dependent homophone spelling

Not Wanted Date:

Status: Faculty
Phone: (979) 845-2509
E-mail: stevesmith@neo.tamu.edu

Name: Steven Smith

Pickup at Evans

Psychology Department
MS# 4235
College Station, TX 77843

Johnson-Laird, P. N. (1981). Mental modes of meaning. In A. Joshi, I. Sag, & B. Nash-Webber (Eds.), *Linguistic structure and discourse setting* (pp. 106–126). Cambridge, MA: Cambridge University Press.
Kintsch, W. (1974). *The representation of meaning in memory.* Hillsdale, NJ: Erlbaum.
Kintsch, W., Kozminsky, E., Streby, W. J., McKoon, G., & Keenan, J. M. (1975). Comprehension and recall of text as a function of content variables. *Journal of Verbal Learning and Verbal Behavior, 14,* 196–214.
Kintsch, W., & van Dijk, T. A. (1978). Toward a model of text comprehension and production. *Psychological Review, 85,* 363–394.
Marslen-Wilson, W., Levy, E., & Tyler, L. K. (1982). Producing interpretable discourse: The establishment and maintenance of reference. In R. J. Jarvella & W. Klein (Eds.), *Language, place, and action* (pp. 339–378). New York: Wiley.
McKoon, G. (1977). Organization of information in text memory. *Journal of Verbal Learning and Verbal Behavior, 16,* 247–260.
Meyer, B. J. F., & McConkie, G. W. (1973). What is recalled after hearing a passage? *Journal of Educational Psychology, 65,* 109–117.
Morrow, D. G. (1985). Prominent characters and events organize narrative understanding. *Journal of Memory and Language, 24,* 304–319.
Rumelhart, D. E. (1975). Notes on a schema for stories. In D. G. Bobrow & A. M. Collins (Eds.), *Representation and understanding.* New York: Academic Press.
Sachs, J. S. (1967). Recognition memory for syntactic and semantic aspects of connected discourse. *Perception & Psychophysics, 2,* 437–442.
Sanford, A. J., & Garrod, S. C. (1981). *Understanding written language.* New York: Wiley.
Schank, R. C. (1976). The role of memory in language processing. In C. N. Cofer (Ed.), *The structure of human memory* (pp. 162–189). San Francisco: Freeman.
Thorndyke, P. W. (1977). Cognitive structures in comprehension and memory of narrative discourse. *Cognitive Psychology, 9,* 77–110.

Environmental context-dependent homophone spelling

STEVEN M. SMITH
Texas A&M University

FRED R. HEATH
Stanford University

EDWARD VELA
California State University, Chico

Two experiments provided evidence of environmental context-dependent memory using a homophone spelling test (e.g., Jacoby & Witherspoon, 1982), an implicit, indirect measure of memory (Richardson-Klavehn & Bjork, 1988). Context reinstatement significantly increased priming in both experiments. The finding of environmental context reinstatement effects with this implicit memory test and others (Garberg & Radtke, 1986; Graf, 1988) indicates that the effect can be found reliably using a test that does not encourage subjects to generate their own context cues from memory.

Is incidental background contextual information associated in memory with intentionally studied verbal material? One experimental approach to this question has been testing memory in the original learning environment versus testing in a different environmental context. Reinstatement of the incidental environmental context in which learning took place has often been found to improve memory relative to testing memory in a different context (e.g., Godden & Baddeley, 1975; Jensen, Harris, & Anderson, 1971; S. Smith & Guthrie, 1924; Smith, 1979, 1985, 1986; Smith, Glenberg, & Bjork, 1978). Some investigations, however, have not found reliable context reinstatement effects (e.g., Eich, 1985; Fernandez & Glenberg, 1985). Why is this effect so erratic?

One hypothesis stems from the finding that *imagined* reinstatment of one's learning environment can improve memory (e.g., Smith, 1979, 1984). This mental reinstatement phenomenon indicates that the environmental contextual cues used by a subject need not be limited to the ambient physical cues supplied by the experimenter; subjects can generate their own contextual cues from memory, regardless of the test context. If ambient contextual material is included by default in memory probes, then context reinstatement effects can

AMERICAN JOURNAL OF PSYCHOLOGY
Summer 1990, Vol. 103, No. 2, pp. 229–242

be expected. If, on the other hand, nonambient context cues related to the study context are intentionally generated by subjects tested in a new context, then the debilitating effect of the changed ambient test environment may be nullified. This line of reasoning is similar to that used by Bjork and Richardson-Klavehn (in press).

When will subjects be moved to generate their own context cues? We hypothesize that explicit, direct tests of memory (e.g., Richardson-Klavehn & Bjork, 1988; Schacter, 1987), which refer subjects to the target events at the study session, are more likely than indirect, implicit measures of memory to encourage subjects to generate their own context cues to deal with the experimental task at hand. We cannot reliably predict when subjects will be moved to intentionally use non-ambient context cues to aid explicit attempts to remember events. Therefore, explicit, direct memory tests may sometimes be impervious to context manipulations, making experimental observation of environmental context effects somewhat unpredictable when explicit tests such as free recall are used.

Implicit memory tests reveal episodic memory by facilitating or biasing performance on tasks that do not require that memory be intentionally addressed (e.g., Schacter, 1987). The term *implicit* can refer either to a type of memory of which one is unaware, or to a technique of measuring memory which does not refer the subject to the originally studied materials. The term *indirect* measure of memory (Richardson-Klavehn & Bjork, 1988) is somewhat less ambiguous, referring specifically to a test in which instructions for the task at hand do not make reference to prior study sessions or target events.

Indirect or implicit measures of memory are not likely to encourage subjects to generate context cues from an earlier study session because the tasks do not refer to the study session. By default, only ambient context information will be included in memory probes, thus resulting in environmental context-dependent memory. The ambient environmental cues for subjects tested in their original learning context should help cue memory, whereas the ambient contextual cues for those tested in a different environmental context should not. Therefore, we predict that indirect, implicit measures of memory should reliably show effects of environmental context manipulations. We do not hypothesize that all direct explicit memory measures will be unaffected by context cues; the published experiments on explicit tests of environmental context-dependent memory clearly contradict that possibility (see Smith, 1988, for a review). Our hypothesis is that reliable effects will be found with indirect measures of memory.

Popular techniques for indirectly measuring memory include word completion (e.g., Tulving, Schacter, & Stark, 1982), word identification (e.g., Jacoby & Dallas, 1981), and homophone spelling (e.g., Eich, 1984; Jacoby & Witherspoon, 1982). The homophone spelling test procedure involves studying a word list that contains low-frequency versions of homophones (e.g., *brake* rather than *break*, *reed* rather than *read*), followed by a test in which aurally presented words (including homophones) are spelled. Spelling homophones as their biased (low-frequency) versions is an indirect measure of event memory. Of the tests available, we chose homophone spelling to test implicit context-dependent memory because prior studies have shown the spelling test to be an effective implicit memory test (e.g., Eich, 1984; Jacoby & Witherspoon, 1982) and event memories are documented using this procedure not by facilitation of performance, but rather by biased responding. Therefore, subjects should not be motivated to intentionally use event memories on the test.

EXPERIMENT 1

In Experiment 1 it was hypothesized that environmental context-dependent memory would be observed on a homophone spelling test, an indirect implicit measure of memory. Recognition memory, which did not show context-dependent results in previous experiments using study and test procedures similar to those in the present experiments (e.g., Eich, 1985; Godden & Baddeley, 1980; Jacoby, 1983; Smith et al., 1978), was not predicted to show context-dependency.

METHOD

Subjects

Subjects were 198 student volunteers from introductory psychology classes at Texas A&M University, who participated in partial fulfillment of a course requirement. They were tested in groups of 6 to 12.

Design and procedure

After hearing instructions to memorize items in pairs, subjects heard a list of 64 word pairs spoken by a male voice on audiotape at 5 s/pair. Half of the groups heard List A and half heard List B. For pairs containing homophones, the biasing cue was spoken first, followed by the homophone.

When the list was completed, subjects were immediately given a two-alternative-forced-choice (2-AFC) cued recognition test over all 64 pairs. Sixty-four nouns, including all 16 of the originally presented homophones, were listed on a page in capital letters, and 2 words (one was the original cue word of the pair) were printed to the right of each noun in lowercase letters. Subjects were asked to circle which of the 2 words had been paired with the noun on the original list. For homophones, both choices were related to the previously biased (i.e., low-frequency) versions. For example, for the original pair *carrot-BEET,* the corresponding item on the initial recognition test was *BEET: a) vegetable or b) carrot.* This 2-AFC cued recognition test was not intended as a criterial performance task, but rather served two other purposes: to repeat exposure to the biased versions of the ambiguous stimuli, and to provide a sense of closure for Session 1, thereby making subjects more unlikely to expect subsequent memory tests. This closure was expected to help prevent conscious processing of the targets so that the subsequent spelling test was more likely to be an implicit test of memory. It was also hoped that such closure would increase the situational dissociation between the first and second sessions.

After the 2-AFC cued recognition test, subjects left the room and waited in the hallway for 5 min. Half of the groups returned to the same Session 1 room for Session 2, and half were taken to a new room. Those who returned to their Session 1 room will be referred to as *same context* (SC) groups, and those who were tested in a different room will be referred to as *different context* (DC) groups.

The second session included the two critical memory tests: a spelling test, and a 2-AFC recognition test. For the spelling test, subjects were told to write down the list of words they were about to hear on audiotape, ostensibly in preparation for a subsequent test to be explained later. They were instructed to work quickly, and to write the first spelling they thought of in cases where they were not certain how to spell a word. Words on this test were spoken at 5 s/word.

After the homophone spelling test, the final 2-AFC recognition test was given. From a page with 64 test pairs, subjects were given 5 min to circle the item from each pair that had been on the original input list.

Materials

Two different input lists (Lists A and B) were constructed so as to be as similar as possible to each other. Each list consisted of 64 word pairs. Word pairs, each consisting of one cue and one target, were of two different types: homophone and filler. Sixteen word pairs contained homophone targets, and 48 others had filler targets. The homophones were drawn from those used by Eich (1984). All targets were English nouns. Cue words designed to bias the meanings of ambiguous words were generated by the authors.

Two different spelling tests (Tests X and Y) were constructed for each presentation list. One half of the homophones from the original input list (i.e., eight homophones) were included on Test X, and the other half were on Test Y. Eight homophone nontargets were also included on each spelling test. The items comprising targets and nontargets were counterbalanced for each list. Sixteen nonhomophone fillers were also included on the spelling tests.

The final recognition test was a 2-AFC test consisting of 64 pairs of test items. One word of each pair was from List A and one was from List B. All 64 of the original list items were used.

Environmental contexts

Rooms were selected to be as different from each other as possible. One room was a large, bright, 50-seat classroom with windows and white walls on the third floor of the building. Subjects sat at stationary individual desks spaced throughout the room. Located on the second floor, the other room was a small, windowless conference room painted a bland green color. Subjects sat at tables with very little room between them.

RESULTS

Homophone spelling

A 2 × 2 (Test Context × Priming) analysis of variance (ANOVA) was computed, using number of biased (low-frequency) spellings on the spelling test as the dependent measure. Test context was either same context (SC) or different context (DC), and was varied between subjects. Priming, a within-subjects factor, was either primed or unprimed.

There was a significant effect of priming, $F(1, 194) = 31.18$, $p < .0001$, $MS_e = 2.057$. Primed homophones were more likely than unprimed homophones to be spelled according to the primed versions (Table 1). There was no effect of test context, $F(1, 194) = .59$, $p = .44$, $MS_e = 2.36$, indicating that across all homophones (both primed and unprimed), biased spellings occurred equally often in SC and DC conditions.

The interaction of Test Context × Priming was significant, $F(1, 194) = 6.88$, $p < .01$, $MS_e = 2.057$. Newman-Keuls pairwise comparisons ($\alpha = .05$) indicated that priming in the DC condition (.050) did not quite exceed the critical value (.054), whereas the observed priming in the SC condition (.154) far exceeded the critical value for the comparison (.066).

Table 1. Mean proportions of primed and unprimed homophones with biased spellings as a function of test context in Experiment 1

	Test context	
Test items	Same	Different
Primed homophones	.38	.32
Unprimed homophones	.23	.26
Priming	.15	.05

Note. Priming = Proportion of primed homophones with biased spellings minus proportion of unprimed homophones with biased spellings.

Recognition

A one-way ANOVA was computed using test context as the independent variable and number of recognition hits as the dependent measure (maximum = 64). There were no effects of test context, $F(1, 196) = 1.23$, $p = .27$, $MS_e = 31.67$. It can be seen in Table 2 that the mean number of hits was slightly greater in the DC condition, although the effect was not significant.

The possibility that context effects may have been obscured by a ceiling effect was examined by breaking down subjects into quartiles on the basis of their recognition scores. For both SC and DC groups, quartiles were determined using the following cutoffs: first quartile, 92% or better; second quartile, 89% to 92%; third quartile, 83% to 89%; fourth quartile, 82% or less. The cutoff points for these quartiles allowed use of the same criteria for SC and DC groups, while defining subgroups of nearly equal size (Table 2). A 2 × 4 (Context × Quartile) ANOVA was computed using recognition hits as the dependent measure. There was no effect of context, $F(1, 190) < 1.0$, nor did context and quartile interact, $F(3, 190) = 1.06$, $p > .05$, $MS_e = 7.49$.

Independence of spelling and recognition

A one-way ANOVA compared the proportion of homophones recognized and given biased spellings with the proportion of homophones recognized but *not* given biased spellings. The proportion of items primed (i.e., given biased spellings) and correctly recognized was .92, and the proportion of items *not* primed but correctly recognized was .90. This difference was not significant, $F(1, 196) = 2.72$, $p > .05$, $MS_e = .03$, indicating that the two tests were independent.

DISCUSSION

The hypothesis that incidentally stored environmental contextual associations would become manifest when measured by an implicit memory measure, homophone spelling, was clearly supported by the results of Experiment 1. Priming, as measured by homophone spelling, was considerably greater in the SC condition as compared with the DC condition. That priming and recognition were statistically independent supports the idea that the homophone spelling test was an implicit one (e.g., Eich, 1984; Jacoby & Witherspoon, 1982).

Recognition memory was not affected by the test environmental context; in fact, slightly more homophones were recognized in the DC condition than in the SC condition, although the difference did not approach significance. That subjects in every quartile of recognition performance failed to show any context effects contradicts the possibility that a ceiling effect may have obscured recognition context effects. This finding that environmental context did not affect recognition replicates well-established findings from a number of previous studies (e.g., Eich, 1985; Godden & Baddeley, 1980; Jacoby, 1983; Smith et al., 1978; Smith, Vela, & Williamson, 1988).

Table 2. Proportion of hits as a function of test context in Experiment 1

	Test context[a]	
Quartile	Same	Different
First	.95 (22)	.96 (23)
Second	.91 (27)	.91 (27)
Third	.86 (21)	.85 (26)
Fourth	.73 (26)	.76 (26)
All subjects	.85 (96)	.87 (102)

[a] Numbers in parentheses indicate number of subjects in each group.

EXPERIMENT 2

Experiment 2 was conducted primarily to replicate the important results of Experiment 1 (i.e., related to context-dependent homophone spelling). One change from Experiment 1 was that a visual, rather than an aural presentation of the original list of pairs was used. The purpose of presenting the items visually was to more clearly disambiguate the homophones at input. Although in Experiment 1 the homophones were given biasing cue words, and they appeared visually with cue words on the initial cued recognition test, there remains the possibility that some homophones were perceived by some subjects as the unintended (i.e., high-frequency) versions in spite of our efforts to control meaning/spelling selection at input. For example, it is possible that some subjects thought of *carrot- BEAT* instead of *carrot-BEET* when they initially heard the pair in Experiment 1, even though *carrot-BEET* was intended. Such possibilities could have decreased the measured priming effect on the homophone spelling test. The visual presentation enhanced our assurance that subjects were perceiving the intended homophonic meaning/spelling from the outset because the words were clearly spelled on the page. We predicted greater priming due to this clearer disambiguation.

METHOD

Subjects

Subjects were 64 student volunteers from introductory psychology classes at Texas A&M University who had not participated in Experiment 1. They were tested in groups of 3 to 8. There were 28 subjects in the SC condition and 35 in the DC condition. Partial fulfillment of a course requirement was earned by participating.

Design, procedure, and materials

The same design, procedure, and materials were used in Experiment 2 as in Experiment 1, with the following exceptions. Rather than being presented on audiotape, the 64 word pairs were printed on a single page for the subjects to study for 6 min.

One other addition to the procedure was made after the final recognition test. Subjects were asked if they intentionally tried to spell the homophones on the spelling test the way they had been biased during the original presentation. It was assumed that the spelling test was not an implicit memory test for those subjects answering *yes* to this self-report question. The 1 SC subject and 4 DC subjects who answered *yes* to this question were eliminated from the analyses.

Environmental contexts

One room was located in the basement of the building. It had blank, white acoustical tile walls, gray carpeting, and a concrete ceiling 3 m high. Subjects were seated in swivel-type padded desk chairs. The other room was located on the third floor of the building. It had off-white walls, chalkboards at the front and back of the room, and hanging fluorescent lights. Subjects sat in chairs lined up along rows of laboratory tables.

RESULTS

Homophone spelling

A 2 × 2 (Test Context × Priming) ANOVA was computed using the number of biased (low-frequency) spellings on the spelling test as the dependent measure. Test context was either *same context* (SC) or *different context* (DC), and was a between-subjects factor. Priming was either primed or unprimed, and was a within-subjects factor.

There was a significant effect of priming, $F(1, 59) = 47.37$, $p < .0001$, $MS_e = 2.102$; primed homophones were more likely than unprimed ones to be spelled the biased way (Table 3). The mean level of priming (i.e., percentage of primed homophones given biased spellings minus percentage of unprimed homophones given biased spellings) in Experiment 2 was 25% across all conditions, as compared with a mean of 10% priming in Experiment 1.

The effect of test context on biased spellings was not significant, $F(1, 59) = 2.20$, $p = .14$, $MS_e = 2.29$, although there was a slightly higher percentage of biased spellings in the SC condition (Table 3). That is, low-frequency spellings of all homophones, primed and unprimed, were slightly more prevalent in the SC condition.

Table 3. Mean proportions of primed and unprimed homophones with biased spellings as a function of test context in Experiment 2

	Test context	
Test items	Same	Different
Primed	.56	.43
Unprimed	.25	.27
Priming	.31	.16

Note. Priming = Proportion of primed homophones with biased spellings minus proportion of unprimed homophones with biased spellings.

Table 4. Proportion of hits as a function of test context and quartile in Experiment 2

	Test context[a]	
Quartile	Same	Different
First	.97 (8)	.98 (8)
Second	.95 (6)	.95 (7)
Third	.91 (11)	.91 (7)
Fourth	.79 (10)	.83 (6)
All subjects	.90 (35)	.92 (28)

[a] Numbers in parentheses indicate number of subjects in each group.

The Test Context × Priming interaction was signficiant, $F(1, 59) = 4.65$, $p < .05$, $MS_e = 2.10$, indicating that priming was greater in the SC condition (31%) than in the DC condition (16%). These data are shown in Table 3. Neuman-Keuls pairwise comparisons indicated that priming effects were significant for both SC and DC conditions ($\alpha = .05$).

Recognition

A one-way ANOVA was computed for recognition memory results, examining the effect of test context (SC vs. DC) on recognition hits. There was a slight advantage for the DC group (Table 4), although the effect did not approach significance, $F(1, 59) = 1.09$, $p = .30$, $MS_e = 22.20$.

As in Experiment 1, the possibility that context effects may have been obscured by a ceiling effect was examined by breaking down subjects into quartiles on the basis of their recognition scores. For both SC and DC groups, quartiles were determined using the following cutoffs: first quartile, 97% or better; second quartile, 94% to 96%; third quartile, 88% to 93%; fourth quartile, 87% or less. The cutoff points for these quartiles allowed us to use the same criteria for the two different treatment groups, while defining subgroups of nearly equal size (see Table 4). A 2 × 4 (Context × Quartile) ANOVA was computed using recognition hits as the dependent measure. There was no effect of context, $F(1, 55) = 1.90$, $p > .05$, $MS_e = 4.03$, nor did context and quartile interact, $F(3, 55) = 1.06$, $p > .05$, $MS_e = 4.03$.

Independence of spelling and recognition

As in Experiment 1, a one-way ANOVA was computed comparing the proportion of homophones recognized and given biased spellings with the proportion of homophones recognized but *not* given biased spellings. The proportion of items primed (i.e., given biased spellings) and correctly recognized was .95, and the proportion of items *not* primed but correctly recognized was .90. This difference was not significant, $F(1, 61) = 3.13$, $p > .05$, $MS_e = .02$, indicating, as in Experiment 1, that the two tests were independent.

DISCUSSION

The results of Experiment 2 replicate the findings of Experiment 1. It was again found that homophone spelling was enhanced by reinstating the input environmental context, whereas recognition memory was not affected.

The use of a visual initial presentation rather than the aural presentation used in Experiment 1 appears to have improved scores on both spelling and recognition tests, but it does not appear to have significantly altered the overall pattern of results. Although repetition priming has been found to be greater when input and test modalities match (Schacter, 1987), as in Experiment 1, the targets were better disambiguated (i.e., they were spelled out on the page) at input in Experiment 2. The improved disambiguation of targets at input apparently overcame the detrimental effects of mismatched input and test modalities.

The subjective reports collected in Experiment 2 suggest further that the homophone test was, indeed, an implicit memory measure. Only a few subjects indicated that they used conscious memory processing on the homophone spelling test, and those were eliminated from the analyses.

GENERAL DISCUSSION

In both experiments evidence of contextual cuing was found for homophone spelling, an indirect, implicit memory measure. At the study session, subjects were not instructed or encouraged to attend to the environment, nor was the context obviously related to the study material. On the homophone spelling test, subjects were not instructed or encouraged to attend to either the context or the studied events. Therefore, the findings of both experiments indicate that incidental background contextual information is both stored in memory and used to probe memory without the obvious intent of the subject.

The homophone spelling test used in the present experiment was, by definition, an indirect memory measure because it made no reference to the studied events. On this test subjects were simply told to write down the words heard on the tape in preparation for a subsequent test. Evidence that indicates that the homophone spelling test used in the present experiments was an implicit memory test includes previous research using the task (e.g., Jacoby & Witherspoon, 1982). These authors pointed out that Korsakoff patients (amnesics) showed a normal level of memory in their homophone spelling performance, whereas the same patients showed extremely low levels of recognition memory. These authors also pointed out the statistical independence of homophone spelling and recognition memory, further implying that spelling may have reflected an implicit test of memory, compared with the explicit recognition test. This same pattern of statistical independence was found in both experiments of the present study. Furthermore, the homophones in the present study were embedded in a long list of words; therefore, the homophones used were well camouflaged, making subjects less aware of their special ambiguous status. A memory test over the studied targets (the immediate 2-AFC cued recognition test) had been given earlier; subjects had been told that the memory test was over, and that a new task would begin. Finally, subjective reports helped eliminate the few subjects who claimed to have intentionally tried to use explicit memory to guide spelling. Thus, the homophone spelling test meets numerous criteria for being considered an indirect, implicit test of memory.

Environmental context-dependent recognition memory was not found in either study, even for subjects whose recognition performance was well below ceiling. This non-finding replicates numerous other results from studies that have also failed to find an effect of context-dependent recognition (e.g., Eich, 1985; Fernandez & Glenberg, 1985; Godden & Baddeley, 1980; Jacoby, 1983; Smith et al., 1978; Smith et al., 1988). An unusual exception to these failures (Smith, 1986) found context-dependent recognition following an incidental, nonrelational input task (a short-term memory test). No such unusual study task was used in the present experiments, in which subjects were instructed to intentionally associate word pairs in preparation for a memory test. Therefore, we predicted (and found) no effect of context on recognition. The absence of an environmental context-dependent effect on recognition does not prove that recognition memory (following intentional relational input processing) is not affected by context manipulations; that inference can be made from the published literature on the topic. The present finding of no effect of context on recognition helps establish continuity with the existing context-dependent memory literature, and indicates that potential experimental artifacts did not appear to affect comparisons of homophone spelling in the two context conditions.

Although Jacoby (1983) did not find context-dependent memory using a perceptual identification test, studies other than the present one have found evidence of context-dependent memory using implicit, indirect measures other than homophone spelling. A study by Garberg and Radtke (1986) found results consistent with the present findings; repetition priming, as measured by anagram solution, was faciitated by environmental context cuing. The solutions for this task were words presented earlier in the same or different context. If anagram solution functions as an implicit measure of memory, as suggested by Schoen and Gettinger (1988), then these results constitute another case of implicit environmental context-dependent cuing. Similarly, Graf (1988) found evidence of environmental context-dependent category production, another implicit memory test. These studies, as well as our present results, stand in contradiction to suggestions that incidental environmental context information is not stored in memory (Eich, 1985), or that manipulations of laboratory rooms do not reliably cue memory (Fernandez & Glenberg, 1985).

Our understanding of memory cues is complicated by the idea that context effects on direct, explicit measures of memory may depend upon which cues are intentionally used to probe memory. For one thing, if subjects are moved to generate their own relevant context cues from memory, then experimental context manipulations are unlikely to affect memory (e.g., Smith, 1979, 1984). Second, it has been noted that background context cues appear to lose their cuing effectiveness on direct, explicit tests when other cues are provided by the test (e.g., Eich, 1980; Smith et al., 1978). Therefore, indirect, implicit memory measures should be sensitive to the effects of incidental context cues because such tests do not encourage the explicit use of associations stored during the initial study session.

It is important to note that we do not claim that direct, explicit tests of memory are impervious to manipulations of environmental context. Indeed, dozens of experiments have shown context-dependent memory using explicit tests of memory (see Smith, 1988, for a review). What we do suggest is that the possibility of intentionally using invisible cues on direct, explicit tests complicates inferences about the use of incidental context cues. Such complication is reduced by the use of indirect measures, which are not likely to encourage the intentional use of cues related to the input events.

We believe that implicit cuing by environmental contexts is not limited to laboratory findings, but may also be seen in naturalistic examples. One's way of thinking and behaving is often implicitly colored by the background setting. Different ways of speaking and interacting with others may be implicitly biased, for example, by settings such as a theater, a classroom, a courtroom, a bar, or a place of religious worship. Such implicit environmental cuing helps us to compartmentalize our everyday lives.

Notes

This research was supported by NIMH Grant 1 R01 MH39977-01 to Steven M. Smith. Experiment 1 was based on a University Fellows Project from Texas A&M University by Fred R. Heath, supervised by Steven M. Smith, and was presented in part at the Southwestern Psychological Association convention in Fort Worth, TX, in April 1986.

Correspondence concerning this article should be addressed to Steven M. Smith, Department of Psychology, Texas A&M University, College Station, TX 77843. Received for publication December 21, 1988; revision received April 26, 1989.

References

Bjork, R. A., & Richardson-Klavehn, A. (in press). On the puzzling relationship between environmental context and human memory. In C. Izawa (Ed.), *Current issues in cognitive processes: The Tulane Floweree Symposium on Cognition.* Hillsdale, NJ: Erlbaum

Eich, J. E. (1980). The cue-dependent nature of state-dependent retrieval. *Memory & Cognition, 8,* 157–173.

Eich, J. E. (1984). Memory for unattended events: Remembering with and without awareness. *Memory & Cognition, 12,* 105–111.

Eich, J. E. (1985). Context, memory, and integrated item/context imagery. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 11,* 764–770.

Fernandez, A., & Glenberg, A. M. (1985). Changing environmental context does not reliably affect memory. *Memory & Cognition, 13,* 333–345.

Garberg, R. B., & Radtke, R. C. (1986, May). *Contextual specificity of repetition priming.* Paper presented at the meeting of the Midwestern Psychological Association, Chicago, IL.

Godden, D. R., & Baddeley, A. D. (1975). Context-dependent memory in

two natural environments: On land and underwater. *British Journal of Psychology, 66,* 325–332.
Godden, D. R., & Baddeley, A. D. (1980). When does context influence recognition memory? *British Journal of Psychology, 71,* 99–104.
Graf, P. (1988, November). *Implicit and explicit memory in same and different environments.* Paper presented at the meeting of the Psychonomic Society, Chicago, IL.
Jacoby, L. L. (1983). Perceptual enhancement: Persistent effects of an experience. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 9,* 21–38.
Jacoby, L. L., & Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. *Journal of Experimental Psychology: General, 3,* 306–340.
Jacoby, L. L., & Witherspoon, D. (1982). Remembering without awareness. *Canadian Journal of Psychology, 36,* 300–324.
Jensen, L. C., Harris, K., & Anderson, D. C. (1971). Retention following a change in ambient contextual stimuli for six age groups. *Developmental Psychology, 4,* 394–399.
Richardson-Klavehn, A., & Bjork, R. A. (1988). Measures of memory. *Annual Review of Psychology, 39,* 475–543.
Schacter, D. L. (1987). Implicit memory: History and current status. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 501–518.
Schoen, L. M., & Gettinger, C. (1988, November). *Anagram solution as a measure of implicit memory.* Paper presented at the meeting of the Psychonomic Society, Chicago, IL.
Smith, S., & Guthrie, E. R. (1924). *General psychology in terms of behavior.* New York: Appleton-Century.
Smith, S. M. (1979). Remembering in and out of context. *Journal of Experimental Psychology: Human Learning and Memory, 5,* 460–471.
Smith, S. M. (1984). A comparison of two techniques for reducing context-dependent forgetting. *Memory & Cognition, 12,* 477–482.
Smith, S. M. (1985). Background music and context-dependent memory. *American Journal of Psychology, 98,* 591–603.
Smith, S. M. (1986). Environmental context-dependent recognition using a short-term memory task for input. *Memory & Cognition, 14,* 347–354.
Smith, S. M. (1988). Environment context-dependent memory. In G. Davies & R. Thomson (Eds.), *Memory in context: Context in memory* (pp. 13–34). Chichester, England: Wiley.
Smith, S. M., Vela, E., & Williamson, J. E. (1988). Shallow input processing does not induce environmental context-dependent recognition. *Bulletin of the Psychonomic Society, 26,* 537–540.
Tulving, E., Schacter, D. L., & Stark, H. A. (1982). Priming effects in word-fragment completion are independent of recognition memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 8,* 336–342.

Spatial localization discrepancies: A visual deficiency in poor readers

ROBERT T. SOLMAN
University of New South Wales, Australia

JAMES G. MAY
University of New Orleans

In two studies, we compared the size of the spatial discrepancies made by young, good and poor readers when locating patterns in space. In the first study, each child was asked to point to the location of a briefly displayed pattern in a 7 × 7 matrix, and the discrepancy between the target's location and the child's response was recorded. The pattern was either a shape or a letter, and the target appeared at nine distances from the middle of the display. The discrepancies made by both groups of children increased with eccentricity, but the rate of increase was significantly greater for the poor readers. The second study required that two temporally and spatially separated target patterns be located on each trial. The discrepancies between their positions and the positions specified by the children were recorded for each target as a function of its eccentricity, and the results for both targets were similar to those obtained in the first study. That is, the discrepancies made by both groups of children increased with eccentricity, but the rate of increase was significantly greater for the poor readers. It was argued that the results of both studies are consistent with the hypothesis that poor readers are handicapped by a low-level processing or perceptual deficiency in the visual encoding system.

The accuracy with which good and poor readers can either identify briefly presented letters (or other patterns), correctly locate or position them in space, or do both has concerned a number of investigators (e.g., Fisher & Frankfurter, 1977; Manis & Morrison, 1982; Mason, 1980). Mason showed that although highly skilled and less skilled readers were equivalent at identifying single letters presented at a central fixation point, the less skilled readers were significantly worse at specifying the serial positions of these letters when they were presented at one of four positions in a linear string of dollar signs. She suggested that this deficit in location processing indicated that perceptual or visual encoding processes were important in reading. However, the studies by Fisher and Frankfurter and by Manis and Morrison reported contrasting findings. The former found that their poor read-

AMERICAN JOURNAL OF PSYCHOLOGY
Summer 1990, Vol. 103, No. 2, pp. 243–263