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The isolation effect in implicit memory[1)]

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Two experiments examined the effect of perceptual isolation on implicit word identification and explicit recognition memory. In Experiment 1 isolated words were displayed in a different color from the background words, and isolated words were both better recognized and identified than control words. In Experiment 2, isolated items had a different perceptual format than the background items (pictures or printed words). Identification performance, but not recognition, was better for words than were isolated among pictures than for control words. In contrast, recognition, but not identification, was better for the names of pictures that had been isolated among words than for control words. This pattern provides evidence that the isolation effects in implicit and explicit memory tests are mediated by different processes. The isolation effect in implicit memory is discussed in terms of perceptual integration and redintegration in a transfer-appropriate-processing framework.

Key words: Isolation effect, implicit memory, priming

Many variables facilitate explicit but not implicit remembering. Levels-of-processing, prolonged exposure duration, massed repetition - to mention a few frequently studied variables — all boost performance on explicit recall and recognition tests, but do not enhance performance on perceptual-priming tests like word completion and perceptual identification (for a review see Roediger & McDermott, 1993). Instead, some manipulations that are beneficial for explicit memory actually *impair* priming. For example, self-generation of to-be-remembered words produces less priming than simply reading the words (e.g., Jacoby, 1983), and studying pictures instead of words reduces or eliminates priming on word completion tests (e.g., Roediger & Weldon, 1987).

Most variables simply leave priming unaffected, though, and it seems that a rudimentary amount of shallow visual processing is sufficient to produce normal priming levels. Any additional processing above that minimal required amount does not do much to improve priming memory. For example, Jacoby and Dallas (1981) found that increasing the exposure duration and repeating the presentations of to-be-remembered words at study did not improve implicit tachistoscopic identification. Explicit recognition, in contrast, benefited from both manipulations.

However, there are a few manipulations that have been found to enhance priming. Spaced, or distributed, repetition has been found sometimes to increase priming effects (e.g., Greene, 1990; Nyberg, Nilsson, & Olofsson, 1994). Also, self-generation from *perceptual* cues has been found to increase priming, provided that there is overlap in physical information between study and test. For example, Gardiner (1988) reported that generating words from fragments had a positive effect on priming in word-fragment completion, provided that identical fragments were presented at study and test.

The main purpose of the present paper was to further investigate a third manipulation that has been shown to improve priming performance, namely *perceptual isolation.* In the typical isolation paradigm, one of the items in a study list differs from the other items on some salient dimension.

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Memory for isolated items is compared to memory for items in the same position in homogeneous control lists. For example, free recall of a word typed in red ink that is embedded in a list of black words is compared with free recall of a word at the same position in a list where all items have the same color.

Since the first thorough study of the phenomenon, by von Restorff (1933), isolation has been proven an extraordinary robust means of enhancing performance on tests of explicit memory. More recently, Guynn and Roediger (1995) also reported a positive isolation effect in primed word-stem completion. The present paper aimed at replicating, generalizing, and accounting for the isolation effect in implicit memory.

From a transfer-appropriate-processing perspective (Morris, Bransford, & Franks, 1977; Roediger, Weldon, & Challis, 1989) it is puzzling why only a few manipulations facilitate priming. In explicit memory, the probability of retrieval generally increases with the overlap between encoding and retrieval processing. Since perceptual priming tests are data-driven, involving the identification of partially degraded information, performance should be related to the amount of visual processing at study (i.e., priming should increase as the perceptual encoding operations approach those required at retrieval).

However, it is possible that simply prolonging the exposure to a stimulus does not result in more extensive processing of the kind that would benefit performance on a priming test. In most situations, the required perceptual processing is completed very quickly and additional processing time is used for conceptual, associative and elaborative, processing. This additional processing is very valuable for explicit retention but not for implicit memory. In order to benefit perceptual priming, the additional processing would have to be directed at a more extensive perceptual or sensory analysis (Graf & Ryan, 1990). Graf and Ryan (1990) argued that priming relies on perceptual redintegration, and if the encoding processes are directed at the perceptual features of stimuli they result in more integrated representations, which facilitates redintegration/priming. Elaborative encoding processes, in contrast, are useful for recall and recognition because retrieval involves associative search.

This would explain why both massed and spaced repetition affects explicit memory, but only spaced repetition affects priming. In massed repetition, the item is easily recognized as old and processing can be devoted to conceptual elaboration. In spaced repetition, the item is not immediately recognized and therefore it undergoes more extensive perceptual reanalysis, which serves to increase integration and enhance implicit retrieval. Also, why self-generation from perceptual cues increases priming may be explained in terms of the encoding task focusing processing on the item's perceptual features. For the present purposes, the framework predicts an isolation effect on priming because of a more extensive integrative processing of perceptually isolated items.

A second purpose of the present paper is related to *induced amnesia*, a phenomenon that sometimes accompanies isolation effects. Tulving (1969), discovered that by presenting high-priority words in a list, recall of surrounding words can be inhibited, provided that presentation rate is rapid. A high-priority item is an isolated item that the subjects are told to remember with highest priority (famous names embedded in lists of nouns, in Tulving's case). Subsequent research has replicated Tulving's (1969) findings with different kinds of isolation manipulations and explicit memory tests. Both retrograd and anterograd inhibition have been found on recognition tests as well as recall tests (e.g., Detterman, 1975; Ellis, Detterman, Runcie, McCarver, & Craig, 1971; Schulz, 1971). The effect of induced amnesia on priming, not the isolation effect *per se*, was the main motive for the study by Guynn and Roediger (1995), who used high priority instructions in their experiments. Similar to research on amnesic patients (e.g, Warrington & Weiskrantz, 1970) Guynn and Roediger found that recall was affected (retrograd inhibition) and primed word-stem completion unaffected.

The present experiment was designed to examine induced amnesia, too, although a more conventional isolation paradigm was used, not involving high priority instructions. In Experiment 1 words were isolated by a change of color. Color change is an often used isolation manipulation, and color incongruence does not reduce priming effects

(Zimmer, 1992). Therefore it was expected that color isolation should promote perceptual processing without any negative effects on priming due to perceptual incongruence. Explicit memory was tested with recognition and priming was tested with a perceptual clarification procedure that requires speeded identification of a gradually more visible word.

In Experiment 2, isolation was achieved by a difference in perceptual format. There were two types of isolation lists: In one a printed word was embedded in a list of pictures, in the other a picture was isolated among words. The purpose of this comparison was to rule out the possibility that the priming test was contaminated by explicit retrieval.

With regard to "induced amnesia", an inhibition was expected for recognition but not for identification.

Experiment 1

Method

Subjects. Twenty-four female and sixteen male students volunteered for the experiment. The mean age was 20 years.

Materials. Two hundred five to six letter nouns were matched for frequency and length and divided into two sets. One set was presented for study and the words from the other set were added as distractors at test. Study and distractor sets were rotated across subjects. Two-hundred additional words were added as buffers to the study lists. Twenty study lists of fifteen words each were prepared. Five of the words were recency buffers and five were primacy buffers. The distribution of buffer items across lists was randomized for each subject. Five words were target words. They were rotated over positions six to ten so that, across subjects, each target word appeared equally often in each position. The critical positions were the seventh, eight, and ninth position, which were used to examine the potential inhibition and facilitation effects, respectively.

Perceptual clarification test. Test words were displayed pixel by pixel in a small square centered on a computer screen. One pixel was added every 1/60 s in a pseudo-random spatial order. Hence, the density of the pixel pattern increased randomly but at a fixed rate, making the words gradually more visible.

Procedure. The subjects were tested individually. They where seated in front of a monitor and keyboard connected to a Macintosh computer. The experiment comprised 20 nested study and test trials. Half of the lists were experimental lists in which the word in position eight was displayed in a different color that differed from the background items. For half of the subjects the color of background items was blue whereas isolated items were red; the colors were reversed for the other half of the subjects.

The subjects were told that they would receive an unspecified memory test at the end of the experiment (there was no final test: The instruction was only intended to make sure the subjects studied the words properly). The subjects in the recognition group were told that they would receive a recognition test after each study trial. The subjects in the identification group were told that, between trials, they would be required to identify various words and that the purpose was simply to see how quickly this could be done. They were told to respond as quickly and accurately as possible and that they should not try to think back to previous study lists.

The subjects started each trial by pressing the space bar. Each word was presented at the center of the screen for one second and then immediately replaced by the next word. A memory test followed immediately after each list that included the five critical words from the preceding study list mixed with five distractors. All test words were displayed in black color. Half of the subjects were given a yes/no recognition task and the other half the identification task. In the recognition test one test word at a time appeared on the screen above two "buttons" (labeled "yes" and "no", respectively). The subjects responded by using the mouse to click at the appropriate button. In the identification test subjects pressed the space bar to start the presentation of a test word and then pressed it again as soon as they could identify the word. They were told to do this as quickly and accurately as possible. Upon pressing the space bar, the pixel pattern was replaced by a prompt to type the identified word on the keyboard.

Results and Discussion

The data was analyzed using one-tailed planned comparisons for each critical input position in the isolated and control lists. α was set to 0.05.

Recognition. As can be seen in Table 1, the false alarm rates were low for the two isolation lists and their controls. Therefore, unadjusted hit scores were analyzed. It can be seen from Table 1 that recognition was better for isolated words than for control words, $t(19)=3.19$. Recognition of words positioned immediately before and after isolated words was lower than for their respective controls, and the anterograd inhibition was significant, $t(19)=-2.21$. MS error for these comparisons was 1.66. This result is similar to earlier research.

Identification. The dependent variable was the number of pixels that were required for identification. For the sake of clarity, these numbers will be converted and referred to as response time latencies in seconds instead of number of pixels. Baseline response time, the time it took to identify nonstudied words, was 9.89 and 9.81 s for the Isolated and Control conditions, respectively.

Less than 1% of the responses were incorrectly named. These errors were replaced with average RT for that condition. 5.2% of the observations were more than two SDs off the mean; these outliers were also replaced with average RTs.

MS error for the planned comparisons was 1071.59. As can be seen in the Table, Isolated words were responded to faster than control words, $t(19)=1.86$. This result agrees with Guynn and Roediger (1995) who also reported a significant isolation effect in primed word-stem completion.

There was no sign of retrograd inhibition, which is also in line with Guynn & Roediger's (1995) results.However, in contrast to their results, there was significant anterograd inhibition, but only at position +2, $t(19)=1.74$. The increase in response time could be due to deficient processing of the items that follow an isolated item. However, it is not immediately apparent why the effect should be stronger at position +2 than +1.

The finding of an isolation effect in primed identification was encouraging, but parallel effects between recognition and identification might be due to explicit, rather than implicit, retrieval in the identification task. Experiment 2 was designed to examine if the basis for the isolation effect in identification was implicit or explicit retrieval.

Table 1 Proportions of recognized critical and surrounding words from isolated and control lists, in Experiment 1

Position	List Type: Isolated	Control	D
-2	0.68	0.66	0.02
-1	0.63	0.68	-0.05
Critical	0.80	0.67	0.13 *
+1	0.64	0.73	-0.09 *
+2	0.69	0.70	-0.01
False Alarms	0.07	0.06	

Note. Significant differences are marked with an asterisk

Experiment 2

Perceptual priming is typically reduced or altogether eliminated by a change of perceptual format. For example, studying pictures improves recognition of picture names but reduces or eliminates priming on word-fragment completion (e.g., Roediger & Weldon, 1987; Roediger, Weldon, & Challis, 1989). This sensitivity to format change was utilized in Experiment 2 to examine whether explicit retrieval was involved in the identification task.

Two types of isolated lists were used, one in which a word was isolated among a series of pictures, and one in which a picture was the isolated item and words the background items. The control lists were homogeneous lists of words.

Table 2 Priming in seconds in identification of critical and surrounding words from isolated and control lists, in Experiment 1

Position	List Type: Isolated	Control	D
-2	1.34	1.11	0.23
-1	1.17	1.15	0.02
Critical	1.61	1.29	0.32 *
+1	0.92	1.14	-0.22
+2	0.93	1.23	-0.30 *

Note. Significant differences are marked with an asterisk

Since recognition is not sensitive to format changes, isolation effects were expected for both isolated words and isolated pictures. More critically, if retrieval is predominately implicit, an isolation effect should only occur with isolated *words*. Due to the incongruent formats, identification of isolated picture names should be worse than for control words. In contrast, the occurrence of an isolation effect for incongruent formats is evidence that it is mediated by explicit and not implicit memory.

Method

Subjects. Thirty-five students from the University of British Columbia participated in the experiment in exchange for course credits. Twenty were assigned to the identification group and fifteen to the recognition group.

Materials. A set of 80 drawings were selected from Snodgrass and Vanderwart's (1980) norms. The names of the drawings were 5 to 6 letters, of medium familiarly, and the name agreement was 0.8 or higher (it was 1.0 for drawings used at the isolated position). An additional 80 words were selected with the same length and similar frequency as the drawing names. In addition to these critical items, 40 pictures and 120 words were selected as filler items. Sixteen lists were prepared, four with isolated drawings, four with isolated words, and four control lists for the respective conditions. The order of the isolated picture and isolated word lists, and the target and distractor sets, were rotated across subjects.

Procedure. Same as in Experiment 1 except that the exposure duration was reduced to .75 seconds in order to possibly increase the effects.

Results and Discussion

Again false alarms were few, as can be seen in Table 3, and unadjusted hit scores were analyzed. MS error for the comparisons between isolated words and controls was 0.54.

As can be seen from Table 3, the names of isolated pictures were recognized more often than control words, $t(14)=3.17$, but not other differences were significant. This is in line with previous research showing that explicit retrieval is not sensitive to format congruence (e.g., Roediger, Weldon, & Challice, 1987).

In contrast, isolated words were recognized less frequently than control words, though the difference was not significant. This was unexpected, but not surprising considering that words are disadvantaged compared to pictures. Picture names were better recognized at all positions, except position -2 where they recognition was equal for control words, though the effect was only significant at position +2, $t(14)=3.44$.

Identification

The MS error for planned comparisons involving the isolated word and isolated word conditions were 2355.11 and 2370.16, respectively. Baseline identification latencies were 8.95, 8.98, 8.87 and 9.26, for the isolated word, isolated picture, and their respective control lists.

The response times are displayed in Table 4. It can be seen that, for words that had been isolated among pictures, response time was shorter than for control words, $t(23)=3.34$. Response times for words that had been presented at pictures were slower at all other positions, though the difference

Table 3 Proportions of recognized critical and surrounding words from isolated and control lists, in Experiment 2

Position	List Type: Isolated	List Type: Control	D
Lists with Isolated Words			
-2	0.75	0.75	0.00
-1	0.83	0.77	0.06
Critical	0.63	0.72	-0.09
+1	0.82	0.78	0.04
+2	0.93	0.75	0.18 *
False Alarms	0.08	0.11	
Lists with Isolated Pictures			
-2	0.57	0.72	-0.15
-1	0.80	0.78	0.02
Critical	0.93	0.67	0.27 *
+1	0.67	0.78	-0.11
+2	0.73	0.75	-0.02
False Alarms	0.09	0.12	

Note. Significant differences are marked with an asterisk

Table 4 Priming in seconds for critical and surrounding words from conditions involving isolated words, isolated pictures, and their respective control conditions, in Experiment 2

Position	List Type		D
	Isolated	Control	
Lists with Isolated Words			
-2	1.17	1.41	-0.24
-1	0.26	0.94	-0.68 *
Critical	1.29	0.51	0.78 *
+1	0.71	1.08	-0.37
+2	0.61	1.41	-0.81 *
Lists with Isolated Pictures			
-2	1.25	1.32	-0.07
-1	0.71	1.25	-0.54 *
Critical	0.92	1.15	-0.23
+1	0.91	1.17	-0.26
+2	0.68	1.14	-0.46 *

Note. Significant differences are marked with an asterisk

were only significant at positions -1 and +2, $t(23)=-3.34$ and $t(23)=3.47$, respectively.

Response times to names of isolated pictures were longer than for control words, although this difference failed to reach significance. This is the opposite pattern from the recognition test, which showed an advantage of pictures over words. Format congruence, which had no effect on explicit RN, was essential for primed identification. This reversed pattern of results strongly suggests that retrieval is based on different processes in these two tests, and that the isolation effect in primed identification is a true implicit phenomenon, not due to explicit contamination.

In the isolated picture lists, there was a retrograd inhibition at position -1 and anterograd inhibition at position +2.

General Discussion

The clear isolation effect with congruent formats and the lack of an isolation effect with incongruent formats renders it unlikely that conceptual processing, either in the form of conceptual priming or explicit contamination, is responsible for the isolation effect in priming. It is possible that conceptual processes may contribute to the effect, and the data suggest that there is a partial transfer between formats, but the bulk of the effect seems to be mediated by different processes in explicit and implicit tests. Comparing the effects on recognition and identification of the picture vs word format, it is clear that explicit retrieval can only play a minor role in producing the isolation effect in identification. The effect must therefore have a perceptual basis here. In contrast, the isolation effect in recognition seems mainly conceptually driven, considering that the effect did not benefit from preserving perceptual format between study and test. The, for explicit memory, more potent picture format overshadowed the isolated words, which were more poorly recognized than control words (the disadvantage was not significant, however).

The present Experiments and the three experiments by Guynn and Roediger all found significant isolation effects in priming, so the effect has been consistently observed in both word-stem completion and perceptual clarification procedures. Moreover, both variation in exposure duration (between Guynn and Roediger's Experiment 1 and 2), and levels-of-processing manipulations (Guynn & Roediger's Exp 3), affected free recall but not stem completion performance, suggesting that the effect was truly due to implicit memory.

A difference between the present Experiments and those by Guynn and Roediger is the finding of induced inhibition in the present experiments. This discrepancy might be due to procedural differences. In the present experiments memory was tested after each list whereas Guynn and Roediger (1995) gave the test after six lists had been studied. Thus, the effect might be either be transitory or the present test more sensitive than the word-stem test employed by Guynn and Roediger. Anterograd inhibition in priming is compatible with a transfer-appropriate-processing account. It can be explained both for recognition and priming in terms a disruption by the isolated item that results in deficient processing of items that follow it. Deficient associative processing impairs explicit memory and it is likely that deficient perceptual processing would impair priming. However, it is not clear why there should be more inhibition of items at position +2 than +1, as in the present experiments. Therefore, interpretation should be tentative.

At any rate, the main results from the present experiments was that priming can be facilitated by a task that arguably promotes integrative processing, provided that test and study cues are physically similar (cf. Gardiner, 1988). This adds to the rare cases showing enhanced priming (compared to the many examples of detrimental effects), and suggests that increasing the overlap in study-test processing can be as beneficial for priming as it is for explicit remembering.

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