Memory & Cognition
1995, 23 (3), 383-386

Notes and Comment

Very rapid forgetting: Reply to Cunningham, Healy, Till, Fendrich, and Dimitry

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In this comment, it is argued that the experiments by Cunningham, Healy, Till, Fendrich, and Dimitry (1993) do not constitute failures to replicate Muter's (1980) finding of very rapid forgetting and do not undermine the conclusion of more rapid forgetting from primary memory than had previously been estimated. In Cunningham et al.'s experiments, expectancy of recall after a filled retention interval, a crucial variable in very rapid forgetting, was more than an order of magnitude higher than in Muter's experiments, and the distracting task was substantially easier.

Peterson and Peterson (1959) found that three letters could be recalled correctly only about 10% of the time after 18 sec of distracting activity. These data, replicated many times (e.g., Murdock, 1961) have often been cited in estimating forgetting rates from short-term memory or primary memory. Muter (1980) claimed that a better estimate could be obtained by studying forgetting under conditions in which subjects did not expect a recall test with distracting activity during the retention interval. Under these conditions, perhaps less contaminated by secondary memory involvement, three letters could be recalled correctly only about 10% of the time after only 2 or 4 sec of distracting activity (Muter, 1980).[1] Similar results were obtained by Sebrechts, Marsh, and Seamon (1989). In an attempt to investigate this finding of very rapid forgetting further, Cunningham, Healy, Till, Fendrich, and Dimitry (1993) found much less rapid forgetting. In the present comment, it is argued that Cunningham et al.'s procedures lack some of the necessary conditions for studying forgetting from primary memory, and that their data do not cast doubt on the finding of very rapid forgetting.

Comparison of Muter (1980) and Cunningham et al. (1993)

How rapid is forgetting from primary memory? If a person looks up a phone number and is distracted, how rapidly is the information lost? It is often assumed that answers to these questions are provided by the classic studies of Peterson and Peterson (1959) and Murdock (1961). But in those studies, subjects knew beforehand that they would be tested after a retention interval filled with a distracting activity. Muter (1980) argued that, because of theoretical and empirical developments largely stemming from Craik and Lockhart (1972), better answers to these questions could be obtained by testing subjects under conditions in which recall with a filled retention interval was not expected. Muter attempted to arrange this expectation by having subjects do one of two things on the vast majority of trials: study and then recall items after an unfilled retention interval; or study the items and perform the distracting activity with no recall test. The critical trials—involving study, distracting activity, and test, and thus similar to the trials of Peterson and Peterson (1959) and Murdock (1961)—made up only 1% or 2% of all trials. Under these conditions, forgetting on critical trials was much more rapid than in Peterson and Peterson and Murdock. Muter suggested three possible reasons for the more rapid forgetting: less cheating during the distractor period; directed forgetting; or a different kind of processing of to-be-remembered items, resulting in minimal formation of secondary memory traces.

Two experiments by Cunningham et al. (1993) did not yield very rapid forgetting. In these experiments, subjects were presented with two four-letter segments followed by a distracting activity. In Experiment 1, recall expectancy was varied by means of precues indicating which segment would have to be recalled; sometimes subjects were misled and were required to recall a segment unexpectedly. For example, in the 75% precue condition, the precue was misleading 25% of the time; that is, 25% of the time, the postcue indicated recall of the segment that had not been indicated by the precue. In Experiment 2, subjects were told that the segment to be recalled first was unimportant, and that points would be awarded only for the segment that was to be recalled second. In fact, the experimenters were interested in both "unimportant" and "important" segments.

In my opinion, the experiments of Cunningham et al. (1993) were well done and provide us with a large amount of useful data. However, it is difficult to know why very rapid forgetting was not obtained, because Cunningham et al.'s experiments differed in several potentially important ways from Muter's (1980). Some of the differences between Muter's studies and Cunningham et al.'s are outlined in Table 1. The expectations of the subjects regarding the probability of a test after a filled retention interval were much higher in Cunningham et al. than in Muter. The distracting task consisted of shadowing single digits, as opposed to counting backwards by threes

I thank the reviewers and Colin M. Macleod, Bennet B. Murdock, Jr., Allison B. Sekuler, Norman J. Slamecka, and Katherine E. Wolkow for helpful comments. Requests for reprints may be sent to P. Muter, Department of Psychology, University of Toronto, Toronto, Ontario, M5S 1A1, Canada (e-mail: muter@psych.toronto.edu).

Table 1
Some Features of Experiments of Muter (1980) and Cunningham et al. (1993)

	Muter	Cunningham et al.
Proportion of trials with recall after a filled interval	< .01 (Exp. 1) < .02 (Exp. 2)	.25 (Exp. 1) .67 (Exp. 2)
Distracting activity	Counting backward by 3s (Exp. 1) Attempting to read aloud and remember four words per sec (Exp. 2)	Reading aloud digits, presented 1 per sec or 2 per sec
To-be-remembered material	Three different consonants, drawn at random on each trial	Two 4-letter segments; always the same, BFHK & LMQR
Kind of information recalled	Item and order	Order only (items always the same, and provided)
Type of recall	Serial recall	(Exp. 1) Partial, cue indicates which segment; (Exp. 2) Full, cue indicates order of recall of two segments

(Muter, 1980, Experiment 1; also, Peterson & Peterson, 1959) or attempting to read aloud and remember words presented at the rate of four per second (Muter, 1980, Experiment 2). Subjects were presented with two four-letter sequences to remember, as opposed to one three-letter sequence as items to be remembered in Muter (and Peterson & Peterson, 1959). During test, the to-be-remembered items—always the same—were displayed, and subjects were required only to report their order, whereas in Muter (and Peterson & Peterson, 1959), to-be-remembered items were three letters, not the same on each trial, and subjects were required to recall both item and order information. In Experiment 1 of Cunningham et al., a postcue indicated which of the two segments to recall; in Experiment 2, a postcue indicated the order of recall of the two segments. In Muter, the task was ordinary serial recall of one sequence.

Expectation

Particularly troublesome among the differences in Table 1 are the expectations of the subjects and the difficulty of the distracting task. An essential feature of Muter's (1980) experiments was that subjects were induced to have a high expectancy of recall with an unfilled retention interval and a low expectancy of recall with a filled retention interval. In Experiment 1 of Muter, subjects experienced a recall test after a filled interval only once, near the end of the experimental session of 128 trials; in Experiment 2, there was a test after a filled interval on less than 2% of the trials. In contrast, for the to-be-remembered items of concern in Cunningham et al.'s (1993) paper, there was a test after a filled interval on 25% of the trials in Experiment 1, and on 67% of the trials in Experiment 2. Thus, Cunningham et al.'s experiments are beyond the boundary conditions implicit in Muter's paper.

With respect to the primary/secondary memory dichotomy, although the modelling in the last section of Cunningham et al. (1993) suggests success in minimizing secondary memory involvement, secondary memory traces may have been formed in spite of the valiant efforts of the experimenters. Indeed, Cunningham et al. point out that there is some evidence that this occurred in their Experiment 1: Performance on no-switch (valid cue) trials of the 75% precue condition was worse than performance in the standard precue condition, suggesting some shift of recall expectancy to the uncued segment in the 75% precue condition (Figures 1 and 2 of Cunningham et al.).

Cunningham et al. (1993) would argue that in their Experiment 2, according to the reasoning of Muter (1980), forgetting rate should have been steeper when less importance was attached to the stimuli, but they do not explicitly present the data that seem most relevant to this point. These data are presented here in Figure 1, which displays proportion correct (Experiment 2, Cunningham et al.) as a function of retention interval for the target (high-importance) and distractor (low-importance) conditions, precue only (unlike Figure 4 of Cunningham et al.), collapsed across exposure rate and serial position, second segment only. (The second segment provides a cleaner estimate of forgetting than does the first segment, which may be affected by the presentation of another segment between study and test.) The data in Figure 1 are means of means in Table 2 of Cunningham et al.; the means in Table 2 of Cunningham et al. have a standard error of .034, as determined by the analysis of variance. The data in Figure 1 strongly suggest a faster forgetting rate in the distractor condition than in the target condition, contrary to Cunningham et al.'s conclusion that forgetting rate was not affected by segment importance. (The corresponding data for Experiment 1 of Cunningham et al. do not exist, because there was no 0-sec retention interval in that experiment; the smallest retention interval was 2 sec. Even in Muter's experiments, there was no evidence of very rapid forgetting beyond a 2-sec retention interval.)

Distracting Activity

A second fundamental requirement for studying forgetting from primary memory is that rehearsal be prevented during the retention interval. It has been demon-

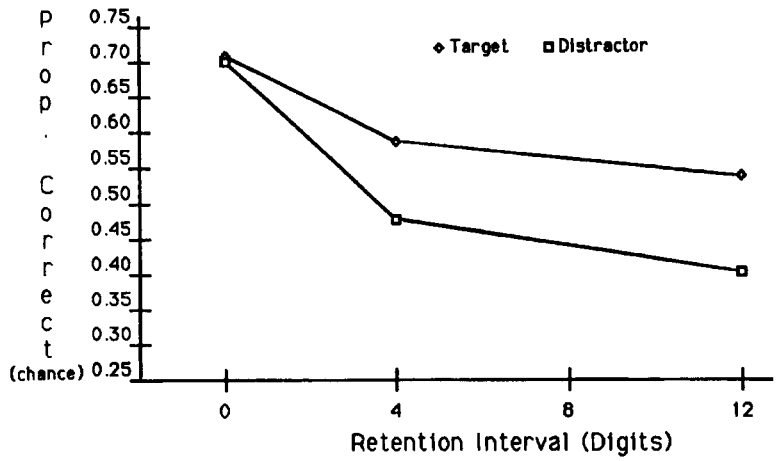

Figure 1. Adapted from Table 2 (Experiment 2) of Cunningham, Healy, Till, Fendrick, and Dimitry (1993): Proportion correct as a function of retention interval and condition, precue only, second segment only.

strated many times that forgetting in short-term memory is a function of the nature of the distracting activity (e.g., Crowder, 1967; Kroll & Kellicutt, 1972; Nakajima & Sato, 1989; Posner & Rossman, 1965). Repeating aloud single digits presented visually at the rate of one or two per second, as in Cunningham et al. (1993), produces less forgetting than does performing an arithmetic task, probably because shadowing digits is not sufficiently distracting to prevent rehearsal. For example, Dillon and Reid (1969) found substantially less forgetting with 15 sec of shadowing pairs of digits (one pair per second) than with 15 sec of arithmetic activity. In Experiment 1 of Dillon and Reid the item scores were .92 with shadowing and .66 with arithmetic; in Experiments 2 and 3, the item scores were .96 with shadowing and .62 with arithmetic. Talland (1967) found that recall was higher when the distracting activity during the retention interval consisted of reading aloud numbers presented visually as opposed to counting backward by threes.

Item and Order Information

Finally, although the title and abstract of Cunningham et al. (1993) question "very rapid forgetting from primary memory," and although on page 672 it is stated that one goal of their experiments is "to examine the rate of forgetting from primary memory," the Cunningham et al. experiments tap only memory for order information, as they state elsewhere. Hockley (1992) and Murdock and Hockley (1989) have demonstrated that rates of forgetting can be different for item information and associative information. Perhaps forgetting rates are also different for order and item information.[2]

Interpretation of the Results from Muter (1980)

With regard to the interpretation of the results from Muter (1980), Cunningham et al. (1993) state that "It is possible that the very rapid forgetting function found ... is attributable to an aspect of ... [the] procedure that may elevate the performance level at the 0-sec retention interval. ... delay interval was confounded with expectancy to recall" (pp. 682-683). It is not true that delay interval was confounded with expectancy to recall in Muter (1980). During presentation of the to-be-remembered material, which is when encoding occurs, subjects had no way of knowing the condition. Expectancy during presentation of to-be-remembered items was identical in all conditions within Experiments 1 and 2 of Muter. Expectancy of recall with a filled interval was low, expectancy of recall with a 0-sec interval was low, and expectancy of recall with an unfilled retention interval greater than zero was high. One cannot speak of differential expectancy during the distractor period, because on 0-sec trials there was no distractor period.

Performance at the 0-sec interval in Muter was similar to that in Murdock (1961). Though Peterson and Peterson (1959) did not include a 0-sec retention interval, extrapolation from their data would produce initial recall similar to Muter's (1980) and Murdock's. In the tradition of Peterson and Peterson and Murdock, cited in the introduction of Cunningham et al. (1993), near-perfect initial performance was virtually a requirement, at least implicitly. In Cunningham et al., initial performance (measured only in Experiment 2) was so poor that it is questionable whether the four to-be-remembered items were ever solidly in primary memory together at any one time: The 0-sec performance (strict scoring) for Segment 2 in Figure 6 of Cunningham et al. is approximately 44%; that is, on only 44% of trials was the sequence recalled completely correctly.

Cunningham et al. (1993) argue that performance may bave been "elevated" at the 0-sec retention interval in Muter (1980), but surely it is plausible that subjects can nearly always recall three letters immediately under almost any reasonable circumstances, given that the letters are in primary memory/consciousness. More likely than elevated initial recall in Muter's experiments is depressed initial recall in the experiments of Cunningham et al., perhaps because of the complex procedures, in-

cluding a memory load. If subjects cannot nearly always recall three letters in primary memory at a 0-sec retention interval, then forgetting from primary memory is even more precipitous than Muter's data indicate.

Conclusion

In conclusion, Cunningham et al.'s (1993) experiments pertain only to order information, and they differ in several potentially important ways from Muter's (1980) experiments. Thus, Cunningham et al.'s experiments do not compromise the finding of very rapid forgetting.[3]

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NOTES

1. Of course, items can be refreshed by rehearsal and thus maintained indefinitely in primary memory (or working memory or consciousness). Schweickert and Boruff (1986) related memory span to the time required to recite items and postulated a "magic spell"—a period after which items will disappear if not rehearsed. Consistent with Muter's Experiment 2, the analysis of Schweickert and Boruff suggested that the duration of this spell is approximately 2 sec.

2. In fact, however, a comparison of Figures 2 and 3 in Muter (1980) indicates that, for both trigram recall and consonant recall, forgetting was dramatically more rapid in Muter's study than in Murdock's (1961) study. Thus, Muter's data suggest that very rapid forgetting occurs both for item and order information.

3. In the reply following this comment, Healy and Cunningham (1995) suggest (p. 388) that "secondary or elaborative processing was likely" in Muter (1980), and that this resulted in elevated performance on the 0-sec trials and hence a steeper forgetting curve. But both theory and data suggest that the formation of secondary memory traces facilitates recall after a filled retention interval, but has a negative effect on immediate recall (Mazuryk, 1974; Mazuryk & Lockhart, 1974).

Healy and Cunningham (1995) suggest that the distractor task in Muter (1980) "served a function not unlike that of the forget cues in the studies of directed forgetting" (p. 389). If directed forgetting accounts for the results in Muter (1980), this speaks only to the issue of the nature of the underlying mechanism of very rapid forgetting. Directed forgetting may be the mechanism underlying the forgetting in Muter (as Muter stated, 1980, p. 178); directed forgetting may occur just after a person has dialed a phone number; and it may in general determine, at least in part, the very rapid forgetting that is, I submit, typical in primary memory.

(Manuscript received November 18, 1993;
revision accepted for publication June 6, 1994.)