The simultaneous learning effect: Why does simultaneous task learning improve retention?

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Despite the prevalence of encoding variables that have been shown to influence the rate of learning, very few affect the rate of forgetting of verbal material. However, when a list of words is learned simultaneously with other lists, the rate of forgetting is markedly lower than that of single-task learning. Although the magnitude of this simultaneous learning effect is large compared with typical list learning effects, it has received little empirical attention. Experiments 1 and 2 tested the hypothesis that the simultaneous learning effect is the result of a differential contribution of short-term memory during encoding. The results showed that the advantage for simultaneous task learning was obtained even under conditions that minimized the potential effects of short-term memory. Experiment 3 revealed that the simultaneous learning effect was larger when the specific items learned simultaneously were the same on each learning trial than when they were different. This finding supported a cuing explanation of the effect: The items from the other lists act as retrieval cues during delayed recall.

Underwood (1972, p. 19) stated that “when differential encoding procedures are induced in learning the same task, the constancy in the rate of forgetting [of a list of verbal items] continues to be observed.” Some 30 years later, it seems that few researchers would agree with Underwood’s conclusions. What evidence has accumulated in the last three decades that refutes Underwood’s claims? The literature is replete with demonstrations that encoding manipulations can affect the rate in which verbal material is learned (e.g., presentation rate, level of processing, and use of imagery to name just a few). It has also been well established that encoding manipulations can affect both the learning and forgetting of motor tasks (e.g., Schmidt & Bjork, 1992). Moreover, several participant variables, most notably age and amnesia, have been reputed to affect forgetting rates (Howe & Courage, 1997; Isaac & Mayes, 1999; Wheeler, 2000). Additionally, several factors occurring during the retention interval, such as the presence of interfering activity (Melton & Irwin, 1940), a change in the expectancy of a retention test (Anderson, Tweney, Rivardo, & Duncan, 1997), and repeated testing (Wheeler, Ewers, & Buonanno, 2003),
have been shown to affect forgetting rates. However, despite a common
misperception, very few encoding variables have been shown to influence
the rate of forgetting of verbal material (Hasher, Riebman, & Wren, 1976;
that measurement of forgetting is controversial when original learning
levels are not equated (Bogartz, 1990; Loftus, 1985; Slamecka & McElree,
1983; Wixted & Ebbesen, 1991), there is little evidence that the way one
encodes verbal materials affects its long-term retention.

The seminal work of Schmidt and Bjork (1992) may be partially respon-
sible for the misperception that encoding variables affect the forgetting of
verbal materials. These authors noted, as did Underwood (1972, 1983),
that the spacing of item repetitions decreases the rate of forgetting relative
to massed presentations. Schmidt and Bjork also noted that varying the
specific task to be learned during acquisition can lead to better transfer
of learning or knowledge to other tasks. However, they did not argue that
variation in practice leads to better retention of the to-be-remembered
task relative to specific practice. Finally, Schmidt and Bjork suggested that
decreasing the amount of feedback during acquisition may increase long-
term retention. However, they based this speculation on the results of a
single study by Schooler and Anderson (1990) involving the learning of
the computer language LISP. The retention test required participants to
solve problems related to but different from the ones they solved during
training, not to remember the actual problems they were shown earlier.
Although Schmidt and Bjork were explicit about the tentative nature of
their speculations, their conclusions may have inadvertently fostered the
belief that many encoding variables affect the rate of forgetting.

With respect to verbal materials, Underwood’s (1972) conclusion seems
to be as accurate today as it was more than 30 years ago. One exception,
however, is the simultaneous learning effect. Delayed recall of a list of
words learned simultaneously with other lists is superior to that of a list
of words learned singly, although original learning often is much worse
(Underwood & Lund, 1979). In a typical simultaneous task learning ex-
periment, participants in the single-task control group are shown a single
list of items (List A) one at a time and then are asked to recall the items
immediately after presentation. The simultaneous task group is shown
three lists of words (Lists A, B, and C) to learn simultaneously. The items
are presented in sets of three, one item from each of the three lists. The
lists are distinguishable from each other in some way; typically they consist
of words from different categories. One of the lists (List A) is the same
list shown to the single-task group. Recall of each of the simultaneously
presented lists is done in succession (List A followed by Lists B and C).
Learning trials continue for both groups until List A is learned to some
criterion (e.g., 9 out of 12 items correct). Then, after a long retention interval, an unexpected free recall test is given.

The typical finding is that single-task learning entails fewer trials to reach criterion, but the rate of forgetting over the retention interval is substantially less after simultaneous task learning (Burns, 2004; Malmi, 1981; Malmi & Burns, 1984; Underwood, 1982; Underwood & Lund, 1979, 1980; Wilson, 1984).

Despite the impressive magnitude of the effect (e.g., in Underwood and Lund’s 1979 study, forgetting was 38% higher in the single-task condition than in the simultaneous task condition), it has largely been ignored. Burns (2004) noted that the probable reason for the lack of interest is that initial explanations of the effect were borrowed from the interference theory of forgetting (e.g., Malmi, 1981; Underwood & Lund, 1979) at a time when interest in interference theory was waning. The scant data available on the simultaneous learning effect will be reviewed next.

A review of the literature

Underwood and Lund (1979) showed that the magnitude of the simultaneous learning effect increases as the number of lists learned simultaneously increases. Presenting three lists simultaneously produced less forgetting across the retention interval than presenting two lists simultaneously, which in turn produced less forgetting than the single-task group. They also showed that the advantage for participants in the simultaneous task group is not simply the result of learning more lists; rather, it is the act of learning them simultaneously that produces the effect. They presented to one group of participants three lists successively (rather than simultaneously), with each list being learned to criterion before presentation of the next list. Those participants forgot at the same rate as the single-task control group.

The advantage of simultaneous task learning over single-task learning is independent of the similarity between the types of simultaneous learning tasks performed. Underwood and Lund (1980) showed that the simultaneous learning effect was as large when the three simultaneous tasks were all the same (e.g., free recall) as when they were all different (e.g., free recall, paired associate learning, and serial recall). They also showed that the simultaneous-learning effect is not limited to free recall; it occurs in serial recall and paired-associate tests as well.

Malmi (1981) showed that the simultaneous learning effect is larger when proactively interfering lists are presented before the target list is learned. Before being presented the target list singly or simultaneously with other lists, half of the participants were given four other lists to learn successively. He found that the simultaneous learning effect was obtained
only when the prior lists were presented. Malmi argued that simultaneous learning minimizes the detrimental effects of proactive interference from previously learned lists. He also suggested that previous demonstrations of the simultaneous learning effect probably resulted from the participants’ exposure to previous list-learning experiments.

Malmi and Burns (1984) extended Malmi’s (1981) results. They first required participants to learn lists singly or simultaneously. Then they presented the target list either singly or simultaneously in a complete crossed-factorial design. The results showed that forgetting was greatest when the type of prior learning and type of target learning were the same. Malmi and Burns suggested that at least a portion of the simultaneous learning advantage may result from the fact that simultaneous task learning is different from most previous learning and therefore protected from interference (see Underwood, 1982, for a different conclusion using a paired-associate learning task).

Research also suggests that physically presenting the items from different lists together during learning is not a necessary condition for the simultaneous learning advantage. In addition to the typical single-task and simultaneous task groups, Underwood (1982) included two additional simultaneous task conditions. In the first procedure, rather than the items from the different lists being presented simultaneously, one item from each list was presented in succession, followed by another item from each list, and so on until all items were presented. The second procedure involved the presentation of all items from one list, then all items from the second list, and then all items from the third list before recall of any of the lists. Recall after presentation was the same as in previous experiments (List A followed by Lists B and C). Interestingly, the simultaneous learning effect was comparable for the three types of simultaneous presentation conditions.

Recently, Burns (2004) reported a series of experiments examining the simultaneous learning effect in a Brown–Peterson–like procedure. Lists of six items were learned singly or simultaneously with other lists, and then recall was tested either immediately or after a short delay. In addition to tests of free recall, order reconstruction tests were given on some trials. The order reconstruction tests assessed the extent to which participants encoded serial order information. Simultaneous task learning produced less forgetting across the retention interval than single-task learning, but single-task learning resulted in higher order reconstruction scores. These results suggest that simultaneous task learning directs attention away from serial order information and toward other types of information.

Clearly, more research is necessary for an understanding of the simultaneous learning effect to emerge. The three experiments reported here make some progress in this direction. Experiments 1 and 2 test the hypoth-
esis that the effect results from a differential contribution of short-term memory during learning, which artifactually inflates original learning scores for single-task learning. Experiment 3 tests a cuing explanation of the simultaneous learning effect.

**EXPERIMENT 1**

In the typical simultaneous learning experiment, participants in the single-task control group are shown a list of 12 items at a rapid rate (e.g., 1 or 2 s per word) and are asked to recall them immediately after presentation. These study–test cycles are continued until the original learning criterion is met. Under these learning conditions, a large portion of the list could be maintained in short-term memory for a sufficient length of time to enhance immediate recall performance. Participants in the simultaneous task group, conversely, are simultaneously shown three lists of 12 words, for a total of 36 words. The words are presented at a much slower rate (e.g., 6 s per three-item stimulus), and then recall is initiated. Under these conditions, it is far less likely that many items from a particular list would be maintained in short-term memory for a sufficient length of time to facilitate immediate recall. Therefore, the typical procedures may result in the original learning scores for the single-task control group being inflated by a larger contribution from short-term memory than the simultaneous task learning scores. Therefore, greater forgetting across the retention interval obtained for the single-task group may simply be the result of more items being lost from short-term memory and not differential forgetting from long-term memory.

This explanation of the simultaneous learning effect, although theoretically uninteresting, is certainly parsimonious. Surprisingly, however, it has not been tested directly. Underwood and Lund (1979) equated the amount of time between successive study trials given to the single-task and simultaneous task groups, but they did so by giving distractor tasks after immediate recall, not before it. Thus, although they equated time between successive study trials they did nothing to equate potential contributions from short-term memory. Underwood (1982) required participants in both the single–task and simultaneous task groups to perform a 30-s symbol cancellation task before recalling the items. He found that single-task learning still resulted in fewer trials to reach original learning criterion and still produced less forgetting across the 24-hr recall period. However, the effect was much smaller than in the previous experiments (a mean difference in forgetting of only 1 item), and a t test between the single- and simultaneous groups would not have been significant. Because Underwood did not include the typical single-task control group without
a 30-s delay, it is impossible to determine whether it was the 30-s delay that was responsible for the decrease in the magnitude of the effect. Additionally, there was no check to verify that the 30-s symbol cancellation task was sufficient to eliminate any short-term memory contributions.

We tested three groups in Experiment 1. In addition to testing the typical single-task control group and the typical simultaneous task group, we tested a third group that was given a 45-s distractor task between list presentation and initial recall to eliminate any contribution from short-term memory in initial recall. To the extent that the simultaneous learning effect results from a differential contribution from short-term memory, we predicted two outcomes. First, the single-task group given the 45-s delay was expected to result in slower original learning than the single-task control group given no delay because the former group’s recall scores would not be inflated by contributions from short-term memory. Second, the delayed single-task group was predicted to produce a rate of forgetting equivalent to that of the simultaneous task group. To verify the effectiveness of the 45-s distractor task at eliminating contributions from short-term memory, we performed an analysis of recall by serial position. To the extent that short-term memory plays a role in enhancing original learning scores in the single-task control condition, a marked recency effect relative to the simultaneous task condition and the delayed single-task condition was expected.

METHOD

Participants

Participants were 88 high school seniors who were enrolled in a government class at a local high school. They were randomly assigned to one of the three encoding conditions and were tested in small groups. There were 29, 28, and 31 participants in the single-task, delayed single-task, and simultaneous task groups, respectively.

Lists and materials

Two of the three lists of 12 words were taken from Underwood and Lund (1979). The target list shown to both of the single-task learning groups contained six names of birds and six names of animals. The two additional lists shown to the simultaneous task group each contained 12 items. One of the lists contained six metals and six cloths; the other list contained six flowers and six trees. The items were presented by means of a slide projector onto a white screen.

Procedure

Participants in the two single-task learning groups were shown the list of 12 items in random order, one at a time, for 2 s each. Participants in the standard single-task group were asked to “recall the birds and animals” in any order immediately after presentation and were given 45 s for written recall. Participants
in the delayed single-task condition were first given a 45-s distractor task of completing math problems (simple addition and subtraction) before being given the 45-s recall test. They were instructed that it was important to try their hardest on the math problems and that their performance would be evaluated. To equate amount of time between learning trials, participants in the single-task control group were given the 45-s distractor task after the recall test. This procedure was then repeated for two more study–test cycles, with the 12 words presented in a different random order on each trial.

Participants in the simultaneous task learning group were also presented 12 slides. However, each slide contained three words, one word from each of the three lists. The three words were presented in random order, and each slide was shown for 6 s. Immediately after presentation, participants were given 45 s for written recall of the target list (the birds and animals). Then they turned the page and were given 45 s to recall the metals and cloths. Finally, they turned the page and were asked to recall the flowers and trees. This procedure continued for five study–test cycles. The specific words from the three lists that were presented together on each slide were determined randomly for each trial, and the 12 target words were also presented in a different random order on each trial. We presented the simultaneous lists for five study–test cycles and the single list for three cycles because, based on previous research (Underwood & Lund, 1979), we believed this would result in roughly equivalent levels of original learning. Twenty-four hours later, participants were given 5 min for an unexpected recall test of the target list items (the birds and animals).

RESULTS

Original learning scores

The mean number of items correctly recalled for each group during each original learning trial is shown in Table 1. The two single-task learning groups learned the target list more rapidly than the simultaneous task group. The two additional learning trials given to the simultaneous task group minimized but did not completely eliminate the difference in original learning levels. The recall difference between groups on the last trial of original learning was significant, $F(2, 85) = 4.64, MSE = 3.64$. A follow-up least significant difference (LSD) test showed that the two single-task groups did not differ from each other but produced significantly higher original learning scores than the simultaneous task group. The mean numbers of items recalled on the remaining two simultaneous task lists are also presented in Table 1. As can be seen, these lists were learned at about the same rate as the target list, suggesting that participants paid attention to these lists and attempted to memorize them.\(^1\)

The fact that the standard single-task group did not produce higher original learning scores than the delayed single-task group suggests that learning scores were not affected by a differential contribution from short-term memory. However, an alternative interpretation is that the 45-s dis-
tractor task was not effective in eliminating contributions from short-term memory. A prediction based on this alternative interpretation is that the recency effects for the two single-task conditions should be of similar magnitude, and they both should be larger than that for the simultaneous task condition.

We calculated serial position curves for each condition for the first trial of original learning.\(^2\) There was much noise in the data, presumably caused by item selection artifacts, because we did not control for the serial location of each specific item (i.e., we did not present each item at each serial position to an equal number of participants). Therefore, we smoothed the curves by averaging data from the adjacent points for each position (e.g., see Roediger & McDermott, 1995). Therefore, the score shown at each serial position in Figure 1 is actually the average of the data from that point and both the preceding and following points (with the exception of the first and last serial positions, which are based on only two points). As can be seen in Figure 1, recall of items in the last three serial positions was substantially higher for the standard single-task group than for the delayed single-task group. Moreover, the simultaneous task group produced consistently lower recall than both single-task groups at all serial positions. The latter finding suggests that the original learning advantage for the single-task group does not result simply from a greater recency effect.

### Forgetting scores

Because there were small differences between groups in original learning, a forgetting (difference) score was calculated to assess the rate of
forgetting. The forgetting score is the change between the number of items recalled on the last trial of original learning and the 24-hr recall test. These scores are shown in Table 1. As can be seen, the forgetting scores were significantly different across groups, $F(2, 85) = 4.65$, $MSE = 2.38$. A follow-up LSD test revealed that the simultaneous task group differed significantly from two single-task groups, which did not differ from each other.

**DISCUSSION**

Experiment 1 tested the hypothesis that the simultaneous learning effect results from a procedural confound that allows single-task original learning to be inflated by contributions from short-term memory. Therefore, the greater forgetting observed across the retention interval for the single-task group may simply be the result of items being lost from short-term memory. The results argue against this interpretation. Analysis of the serial position curves showed both that the 45-s delay was effective at minimizing contributions from short-term memory and that single-task learning
was superior to simultaneous task learning at all serial positions, not just the recency portion of the list. Despite these findings, simultaneous task learning still resulted in slower original learning and less forgetting than single-task learning, even when immediate recall was delayed 45 s for the single-task group.

**EXPERIMENT 2**

Experiment 1 produced significantly greater forgetting in the two single-task groups than in the simultaneous task group. However, the effect was actually quite small: less than a one-item difference in forgetting between the delayed single-task group and the simultaneous group. Furthermore, much of that difference was the result of the simultaneous task group actually experiencing negative forgetting (i.e., hypermnesia). Although the finding of hypermnesia for lists of words learned simultaneously is intriguing in its own right, one could argue that Experiment 1 did not actually test the simultaneous learning effect under conditions of normal forgetting. Experiment 2 addressed this criticism.

**METHOD**

Experiment 2 was a direct replication of Experiment 1 with the following exceptions. First, only the delayed single-task and simultaneous task groups were tested. The standard single-task group was not included because the primary purpose of Experiment 2 was to determine whether the simultaneous learning effect would be obtained under conditions that eliminated potential contributions from short-term memory. Second, on the basis of the results from Experiment 1, we decreased the number of original learning trials for the delayed single-task group from three to two in an effort to more closely equate original learning levels. Finally, to increase the number of items forgotten on the unexpected delayed recall test, the retention interval was increased from 24 hr to 3 wk. There were 19 participants in the simultaneous task group and 17 in the delayed single-task group. The participants were different students selected from the same high school as those tested in Experiment 1.

**RESULTS**

**Original learning scores**

The mean number of items correctly recalled for each group on the original learning trials is shown in Table 2. The delayed single-task group learned the target list more rapidly than the simultaneous task group, as evidenced by the fact that the delayed single-task group recalled significantly more items on the second recall trial than the simultaneous group,
The three additional learning trials given to the simultaneous task group resulted in a final original learning level that was numerically higher than that of the delayed single-task group. However, this numerical difference was not significant, \( F(1, 34) = 2.88, \text{MSE} = 5.38 \). The mean number of items recalled on each trial from the remaining two simultaneous task lists, shown in Table 2, revealed that these lists were learned at about the same rate as the target list. The serial position curves for the first original learning trial for both conditions appear in Figure 2. As can be seen, although there is evidence of a fairly substantial recency effect, it is of roughly the same magnitude for each condition. In addition, as in Experiment 1, the recall advantage for the single-task group is fairly consistent at all serial positions.

### Forgetting scores

As in Experiment 1, forgetting scores were calculated and are presented in Table 2. As can be seen, there was evidence of forgetting across the retention interval in both groups. More importantly, the delayed single-task group forgot a significantly greater number of items than the simultaneous task group, \( F(1, 34) = 4.32, \text{MSE} = 3.11 \), replicating the simultaneous learning effect.

### DISCUSSION

Experiment 1 showed that the simultaneous learning effect was obtained even when the potential confounding effect of a differential contribution from short-term memory was minimized. However, a problem with Experiment 1 was that none of the groups showed much forgetting across the retention interval. Experiment 2 remedied this problem by increas-
ing the length of the retention interval to 3 wk. This procedural change apparently worked because the amount of forgetting was much higher in Experiment 2 than it was in Experiment 1. Moreover, forgetting was greater after single-task learning than after simultaneous task acquisition. Therefore, we conclude that the simultaneous learning effect is not simply the result of a differential contribution from short-term memory.

EXPERIMENT 3

Malmi (1981) proposed a cuing explanation of the simultaneous learning effect. He suggested that during simultaneous learning, associations are formed between the items from the different lists when they are presented together. At time of recall, participants may retrieve items from the other lists and use them as retrieval cues for the list currently being recalled. This cuing hypothesis was tested in Malmi’s Experiment 2. In addition to testing a typical single-task control group and a typical simultaneous task group, he included two other simultaneous task groups that were given cues at time of delayed recall of the target list. One group was

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**Figure 2.** Percentage correct recall as a function of input serial position for both conditions of Experiment 2
given a random half of the items from the remaining two lists as cues, whereas the remaining group was given all of the items from the remaining two lists. Malmi found that delayed recall increased as the amount of cues presented increased from none to all of the items from the other lists. Unfortunately, however, he was unable to replicate the typical simultaneous learning effect because the single-task control group did not differ significantly from the simultaneous task group given no cues. This led Malmi to abandon the cuing hypothesis.

However, we believe that the cuing hypothesis was abandoned prematurely. Malmi’s (1981) failure to replicate the typical simultaneous learning effect appears to be the result of a scale attenuation problem; there was very little forgetting across the retention interval for any of the groups. Furthermore, Malmi’s results did show that providing the items from other lists as cues during retrieval facilitated recall. This finding suggests that the items from the other lists can be effective retrieval cues.

It is actually impressive that the items from the other lists were effective cues at facilitating recall, considering the research on part–set cues. Typically, presenting a subset of the to-be-remembered items hinders recall of the remaining items (Slamecka, 1968). To the extent that the simultaneous items are a set, the items from the other lists might be expected to hinder, not facilitate, recall. It is possible that the memorial benefits of having access to the retrieval cues (from other lists) outweighed the negative consequences of part–set cuing.

In Experiment 3, we tested the cuing hypothesis by using a procedure that would eliminate any negative consequences of part–set cuing. We expected that strengthening the episodic association between the items from the different lists would make them stronger retrieval cues. To this end, we tested three groups. The first group was the standard single-task learning group. The remaining two groups learned three lists simultaneously for five learning trials. For one of these groups, the typical procedure of pairing three different words together on each learning trial was used. For the remaining group, however, the same three words (one from each list) were shown together on each learning trial. To the extent that participants form episodic associations between the words from the different lists, we hypothesized that seeing the same words on each learning trial would strengthen those episodic associations, thereby increasing the cuing effect and improving delayed recall.

**METHOD**

The procedure for Experiment 3 was identical to that of Experiment 1 with the following exceptions. First, only the standard single-task control group was tested. Second, two simultaneous task conditions were tested; the standard simultaneous
task group was identical to the simultaneous task group in Experiment 1. The remaining simultaneous task group differed from the standard group in that the items from each list that were presented together remained the same across the five learning trials (although the random order of the 12 slides differed on each trial). To differentiate the two simultaneous learning groups, we refer to them as the different-cues group and the same-cues group, respectively. Unlike in Malmi’s (1981) experiment, the words from the other lists were not presented as cues during 24-hr recall of List A for either simultaneous learning group. The other procedural departures from Experiment 1 were that we gave only two trials of original learning for the single-task group, and the retention interval was 48 hr. The participants were college students recruited from the psychology department’s participant pool at Union College. Seventeen students were tested in each of the three groups.

RESULTS

Original learning scores

The mean performance scores for each group are shown in Table 3. As in Experiments 1 and 2, the single-task learning group learned the target list more rapidly than the two simultaneous task groups. The three additional learning trials given to the two simultaneous task groups minimized

<table>
<thead>
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<th>Condition</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Trial 4</th>
<th>Trial 5</th>
<th>48-Hr recall</th>
<th>Forgetting</th>
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*Note.* Numbers in parentheses are standard deviations.
the difference in original learning levels. In addition, the same-cues group seems to have learned the target list slightly more slowly than the different-cues group. However, the recall differences between groups on the last trial of original learning did not reach significance, \( F(2, 48) = 2.23, \text{MSE} = 4.86 \). The mean numbers of items recalled on each trial from the remaining two simultaneous lists are also presented in Table 3. As can be seen, the remaining two simultaneous task lists were learned at roughly the same level for the two simultaneous task conditions.

**Forgetting scores**

The forgetting scores presented in Table 3 revealed a significant difference between the three conditions, \( F(2, 48) = 8.24, \text{MSE} = 3.30 \), and the follow-up test revealed that the same-cues group forgot significantly fewer items than either of the other two groups. The difference between the different-cues group and the single-task group (the typical simultaneous learning effect) was marginally significant, \( p = .05 \).

**DISCUSSION**

Malmi (1981) originally proposed that the memorial advantage for simultaneously learned lists over lists learned singly resulted from interlist cuing. Although he abandoned the hypothesis, both his results and the results of Experiment 3 support the notion that the cues from the other lists can facilitate long-term recall. Presenting the same items together on each simultaneous learning trial does not increase the speed of learning, but it does decrease the rate of forgetting relative to changing the items paired together on each trial (Experiment 3). Presenting the items from other simultaneously learned lists as cues at time of the recall test also decreases forgetting (Malmi, 1981). Both of these findings support the contention that interlist cuing is at least partly responsible for the simultaneous learning effect. Presumably, when items from different lists are presented together during learning, associations are formed between them. Later, at time of recall, participants access some items from the lists not currently being recalled and use these items as cues to facilitate recall.

**GENERAL DISCUSSION**

Despite being a robust phenomenon, and although it is one of very few encoding manipulations that affects the rate of forgetting of verbal material, simultaneous learning has received little empirical attention. In addition to replicating the simultaneous learning effect in all three
experiments, we ruled out a theoretically uninteresting interpretation of the effect in Experiments 1 and 2. That artifactual explanation was that a greater number of items could be kept in short-term memory during single-task learning than during simultaneous task learning. The extra items kept in short-term memory would then be lost during the retention interval, producing greater forgetting for the single-task group. We included a single-task group that was given a 45-s delay between seeing the items and recalling the items during original learning in Experiments 1 and 2. The 45-s delay should have eliminated or at least minimized any contributions from short-term memory, and yet simultaneous task learning continued to produce less forgetting. Moreover, analysis of the serial position curves on the first trial of original learning provided no evidence that the difference in original learning was limited to the recency portion of the list.

Experiment 3 tested an interlist cuing explanation of the simultaneous learning effect, which assumes that the items from the other lists act as retrieval cues during long-term recall. When the same items from each list were paired together on every trial of original learning, the simultaneous learning effect was greater than when different items were paired together on each trial. This finding suggests that participants formed associations between the items from the different lists. During delayed recall, they may have accessed some of the items from other lists and used them as retrieval cues to facilitate recall. The items from other lists were more effective retrieval cues when they were consistently paired with the same items during presentation.

Underwood and Lund (1979) argued against a cuing explanation of the simultaneous learning effect on the grounds that simultaneous acquisition did not facilitate learning, only long-term retention. A similar result was obtained in Experiment 3, in which the same-cues group produced better retention, but not faster learning than the different-cues group. Underwood and Lund suggested that if the cues facilitated long-term retention, they should also improve original learning. One possible reason why the items from other lists may not facilitate original learning scores is that original learning is measured with an immediate recall test. It is now clear that the retrieval strategies used during immediate recall of a short list of words may not be the same as those used after a delay (Burns, Curti, & Lavin, 1993; DeLosh & McDaniel, 1996; Nairne, Riegler, & Serra, 1991). Perhaps participants use the items from other lists as cues only during delayed recall and rely on other information (e.g., serial order information) during immediate recall.

It is also not clear how the cuing hypothesis could explain Underwood’s (1982) finding of a simultaneous learning advantage even when the items
from the three lists are not physically presented together. Although one could envision episodic associations being formed with such presentation conditions, it seems that their formation would be far less likely than when the items appear contiguously.

Of course, there are alternative explanations for the results of Experiment 3 and for Malmi’s (1981) results. For example, it is possible that the items from the other lists do not cue recall at all. Rather, presenting them at test might simply decrease list discrimination problems. Presenting the cues at test might simply inform the participant that they were not from the list currently being recalled. Similarly, it is conceivable that pairing the same items together on each learning trial might allow participants to better discriminate between the different lists. Experiment 3 does not allow us to distinguish between these alternative explanations.

It is possible that although cues from other lists may aid retention, this facilitation may be orthogonal to the simultaneous learning effect (see Malmi, 1981). For example, it is possible that the simultaneous learning effect is the result of divided attention during learning. Perhaps any dual-task procedure in which one of the tasks is a memory task would result in greater retention than in the single-task control group. Several researchers have shown that dividing attention during learning impedes acquisition in much the same way as simultaneous task learning impedes acquisition, although the effects of divided attention on retrieval are less clear (Craik, Govoni, Naveh-Benjamin, & Anderson, 1996; Fernandes & Moscovitch, 2000). Although it seems unlikely that divided attention would decrease forgetting of material once it is learned, we could find no studies that directly addressed this possibility. Of course, this divided attention hypothesis does not address why presenting the same words together on each trial or presenting items from other lists as cues at time of test also decreases forgetting.

Malmi (1981) argued that the simultaneous learning effect may result from a reduction in proactive interference from experimental sources (i.e., previous lists in the same experiment or previous list learning experiments). It is worth noting that the present results are inconsistent with this interpretation. Despite the fact that participants in Experiments 1 and 2 were high school students who were unlikely to have been in previous memory experiments, an advantage for simultaneous learning still occurred.

As mentioned earlier, differential rates of forgetting of verbal tasks have been demonstrated as a function of spacing of repetitions (Bahrick, Bahrick, & Bahrick, 1993; Keppel, 1967). Shea and colleagues (Shea & Morgan, 1979; Shea, Kohl, & Indermill, 1990) have shown similar spacing effects in the acquisition and retention of a motor skill, a
finding they viewed as evidence that contextual interference at time of learning facilitates later retention (see Battig, 1966). Moreover, Shea and Morgan’s procedure was similar in many respects to the simultaneous learning procedure. They had participants learn three motor tasks under either a blocked sequence of presentation or a random sequence of presentation. In the blocked sequence, all practice for a particular task was given before practice began for the next task, whereas for the random presentation, practice for the three tasks was intermixed. Although the random sequence produced slower learning, it produced better long-term retention. It could be argued that simultaneous learning is a special case of spaced practice, one in which the material interspersed between successive repetitions of an item is from a different task (list). Although it is premature to suggest that simultaneous learning and spaced practice are related, if the two effects are caused by the same underlying mechanisms, then simultaneous learning may prove to be a useful procedure for studying those mechanisms.

In Experiment 1, the simultaneous task group actually recalled more items during the 24-hr recall test than on the last trial of original learning. This hypermnesic recall did not occur for the single-task groups. This demonstration of hypermnesia is particularly impressive considering the long (24-hr) retention interval used; the typical hypermnesia experiment uses much shorter retention intervals (e.g., 0–10 min). In fact, Wheeler and Roediger (1992) suggested that length of the interval between tests is a primary determinant of the occurrence of hypermnesia, with shorter tests more likely to produce greater hypermnesia (but see Bahrick & Hall, 1993, for an exception). Simultaneous learning may prove to be a particularly effective procedure for producing hypermnesic recall, even with lengthy retention intervals.

A great deal remains unknown about the memorial effects of simultaneous learning. We hope that the research presented here will contribute to a resurgence of interest in this intriguing memory phenomenon.

Notes

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1. Recall performance on the nontarget simultaneous lists is not directly comparable to recall of the target lists for two reasons. First, the lists are composed of different items, some of which may be inherently easier to remember. Second, recall of the target lists always preceded recall of the nontarget lists. The main point, however, is that participants were following instructions and were attending to the nontarget list items.
2. We conducted a serial position analysis only on the first original learning trial because on later trials recall of an item could have been affected by both its serial position on that trial and its position on earlier trials.

References


