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Overstreet, M. F., Healy, A. F., & Neath, I. (2017). Further differentiating item and order information in semantic memory: Students' recall of words from the "CU Fight Song," Harry Potter book titles, and Scooby Doo theme song. *Memory, 25*, 69-83. doi:10.1080/09658211.2015.1125928

Further Differentiating Item and Order Information in Semantic Memory: Students' Recall of Words from the "CU Fight Song," Harry Potter Book Titles, and Scooby Doo Theme Song

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This research was supported in part by National Aeronautics and Space Administration Grant NNX10AC87A to the University of Colorado and by a grant from the National Sciences and Engineering Research Council of Canada to Ian Neath. We thank Elizabeth Maylor for helpful comments on an earlier version of this manuscript.

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Abstract

University of Colorado (CU) students were tested for both order and item information in their semantic memory for the "CU Fight Song." Following an earlier study by Overstreet and Healy (2011), a symmetrical bow-shaped serial position function (with both primacy and recency advantages) was found for reconstructing the order of the 9 lines in the song, whereas a function with no primacy advantage was found for recalling a missing word from each line. This difference between order and item information was found even though students filled in missing words without any alternatives provided and missing words came from the beginning, middle, or end of each line. Similar results were found for CU students' recall of the sequence of Harry Potter book titles and the lyrics of the Scooby Doo theme song. These findings strengthen the claim that the pronounced serial position function in semantic memory occurs largely because of the retention of order, rather than item, information.

Keywords: serial position functions, semantic memory, order reconstruction, item recall

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Nipher (1878) first observed that when people recall items from a list, the items in the middle of the list are more difficult to remember than those at the beginning and end of the list. Although most studies have used tasks in which the learning episode is known, an increasing number of studies have found that this serial position function also applies to information in semantic memory, where the learning episode is unknown or learning occurs spread out across multiple episodes.

Serial Position Functions in Episodic Memory

A number of different theories and models have been put forth to explain the bow-shaped serial position function in episodic memory. The serial position effects observed in immediate memory tasks were initially explained by a dual-store model in which the earliest items are transferred to a long-term store through rehearsal (primacy) and the later items are output from a limited-capacity short-term store (recency; Glanzer & Cunitz, 1966). In contrast, according to the Estes' (1972) perturbation model, the serial position function in immediate recall is due to the fact that the representations of list items are associated in memory to a common control element. A reverberatory loop connects each list item representation to the control element and produces a periodic recurrent reactivation of the items in memory, with a difference in reactivation times among the items reflecting the difference in item input times. The timing of the reactivations therefore provides the representation of order information, and random errors in the reactivations lead to interchanges in the relative timing of two neighboring items and, thus, to order errors in recall. The enhanced recall of the first few items (the primacy effect) and the last few items (the recency effect) occurs because end items can perturb in only one direction whereas all other items are subject to perturbations in both the forward and backward direction. According to perturbation theory, only order information, not item information, should yield a bowed serial position function, as was found to be the case for immediate episodic memory by Bjork and Healy (1974) and Healy (1974).

Although the perturbation model was originally formulated for immediate episodic memory, Nairne (1990, 1991) showed that the model could also be successfully applied to long-term episodic memory. The only change is that item representations are seen as drifting along a dimension (or through multidimensional space if there is more than one dimension). By estimating the rate of drift, Nairne was able to fit recall after as long as 24 hours.

Other models have proposed explanations based on distinctiveness. Murdock (1960) developed a positional distinctiveness model, which suggests that the serial position function results from differences in distinctiveness of the positions that comprise a list. Each position's distinctiveness value (the extent to which a given position "stands out" from the others) is determined in part by the sum of the differences between it and all the other positions in the group. Healy, Shea, Kole, and Cunningham (2008) found that Murdock's model fit the serial position functions observed in experiments involving intentional episodic memory and reconstruction of order tasks.

Nairne, Neath, Serra, and Byun (1997) described a positional distinctiveness model which combined elements of Estes' (1972) perturbation model with Murdock's (1960) distinctiveness model. In most applications of perturbation theory, memory performance is predicted by calculating the probability that an item would have perturbed to a particular position at a particular time. In contrast, the positional distinctiveness model suggests that memory performance depends on the distinctiveness of the position. Nairne et al. (1997) reported experiments which focused on recency, but which demonstrated that the model made accurate predictions for both immediate and delayed free recall. For the purposes of the current experiments, the key idea is that once again only order information gives rise to serial position functions.

Both Murdock's (1960) model and Nairne et al.'s (1997) positional distinctiveness model are global distinctiveness models: All items contribute equally to a given item's distinctiveness. In contrast, Brown, Neath, and Chater (2007) proposed a local distinctiveness model called SIMPLE (Scale Independent Memory, Perception, and Learning), in which distant items play less of a role and closer items play more of a role in determining the extent to which an item stands out.[1] The main free parameter in SIMPLE, *c*, determines the influence of more distant items: As *c* increases, more distant items have less of an effect, and the distinctiveness of a given item is largely determined by only the item's closest neighbors. According to SIMPLE, successful memory for a given item at the time of test depends on how distinct the item is from its close neighboring items. Bonk and Healy (2010) found the SIMPLE model able to predict well performance on a serial reconstruction of order task that manipulated variables that included stimulus type, presentation condition, stimulus grouping, and distractor

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[1] For an extended discussion of the relation between various models of distinctiveness, see Neath and Brown (2007).

condition. Like both perturbation theory and the positional distinctiveness model, SIMPLE predicts that serial position functions are due to differences along the order dimension rather than to item information.[2]

Serial Position Functions in Semantic Memory

In the original study of serial position functions in semantic memory, Roediger and Crowder (1976) performed an experiment that required participants to recall the names of U.S. Presidents from semantic memory and found that the most correct responses occurred at the beginning and end of the chronological list, thus demonstrating a bow-shaped serial position function.

Healy, Havas, and Parker (2000; see also Healy & Parker, 2001) extended Roediger and Crowder's (1976) study by incorporating a reconstruction of order task: Participants were given an alphabetical list of the presidents or vice presidents and were asked to reconstruct the order into the correct chronological sequence. In addition, the participants rated how familiar they were with each name. Although the reconstruction of order task did result in a bowed serial position function with best performance for the earliest and most recent presidents/vice presidents, these results were also significantly correlated with the familiarity ratings, thus suggesting that the presence of primacy and recency

[2] There are situations when SIMPLE predicts that item information can affect the serial position function, but these situations usually occur when the list items do not form a homogenous set; one example is when one item is presented in red and all other items are presented in black, the so-called von Restorff effect (von Restorff, 1933). For the cases under consideration here, the list items can be considered homogenous.

could be a result of differences in frequency of exposure to these positions, instead of the distinctiveness of the positions.

In another task tapping semantic memory, Maylor (2002) tested churchgoers' memory of six-verse hymns using a reconstruction of order task and found a bowed serial position function. In this study, she made an effort to control for familiarity by using lists of items that are learned in a fixed serial order with each item having the same frequency of exposure. Although the hymns are sung in a fixed order, differences in exposure were noted as a possible explanation for primacy effects because part of the first verse of a hymn is usually announced prior to singing the hymn.

In an experiment examining students' semantic memory of their college fight song while controlling for frequency of exposure, Overstreet and Healy (2011) observed serial position effects (both primacy and recency) for reconstructing the order of the lines of the song by students who were familiar with the song, but no effect of position by students who were not familiar with it (and were thus presumably guessing). A second experiment directly examined whether item information results in serial position functions. Lines from the song were presented with one word missing and two possible choices. When the percentage of correctly selected items was analyzed, a bow-shaped serial position function did not occur. In contrast, when participants were asked to place the lines in order, a bowed serial position function was observed. This finding constitutes evidence that in semantic memory tasks, just as in episodic memory tasks, the serial position function occurred because of the retention of order and not item information. For the item selection task, accuracy was much lower for control participants, who did not have previous knowledge of the song, than for experimental participants, with accuracy close to the chance level for control participants. In addition, the serial position functions for the item task had different shapes for the control and experimental participants. Guessing undoubtedly played some role in this task, even among the experimental participants, but guessing alone clearly cannot account for the observed serial position functions.

Overstreet and Healy (2011) advanced an explanation for the different order and item serial position functions found for experimental participants in their study of semantic memory in terms of the Estes (1972) perturbation model because, as mentioned earlier, by this account, only order information, not item information should yield a bowed serial position function, as was indeed found for the "CU Fight Song." Hence, Overstreet and Healy argued that the perturbation model does not apply only to episodic memory, but that it seems to apply to semantic memory as well.

As Overstreet and Healy (2011) acknowledged, the different serial position functions for order and item information might also be explained in terms of the SIMPLE model. Neath (2010) successfully applied the model to the semantic memory task of reconstructing the order of U.S. Presidents, and Neath and Saint-Aubin (2011) applied the model to the free recall of Canadian prime ministers. In both cases two dimensions were used, one for order and one for item information. More recently, Kelley, Neath, and Surprenant (2013) successfully applied the SIMPLE model to five more examples of serial position functions of information in semantic memory, two involving cartoon theme song lyrics, one involving the Harry Potter book series, and two involving sets of movies. In addition, Kelley, Neath, and Surprenant (in press) also demonstrated five additional semantic serial position functions when people ordered exemplars from different categories (i.e., ordering actors by age, animals by weight, basketball players by height, countries by area, and planets by size). However, the task in each of these new cases involved reconstruction of order, with no separate item recall task.

Item and Order Information in Semantic Memory

The crucial finding of different serial position functions for item and order information in semantic memory is, thus, limited to the study by Overstreet and Healy (2011). This finding is therefore in need of empirical confirmation, and such confirmation seems necessary not only because it comes from a single experiment but also because the result might have been due to the specific procedure used in the experiment. In particular, the item task required participants to select one of two alternatives for a missing word from each line of the song. It is possible that the alternatives given might have biased the results, especially if one alternative was much more plausible than another. Furthermore, it is possible that the serial position function depended on the particular word missing from each line, especially if some of the words in a line are much easier to guess than others.

The "CU Fight Song" can be viewed as represented in a hierarchical fashion, divided into separate lines, with each line divided into separate words, following Lee and Estes (1981), who postulated a hierarchical representation of information in episodic memory (see also Farrell, 2012, for another model of episodic memory assuming that temporal context is hierarchically structured). The question arises whether the serial position function for item information in semantic memory depends on the item's location at each level of the hierarchy, namely the location of the item in the line as well as the location of the line in the song. Are the serial position functions at the various levels (for word within line as well as for line within song) bow shaped in each case? Is order information the cause of the observed serial position function at each level of the hierarchy?

To provide a robust confirmation of the different serial position functions for order and item information in semantic memory, the present paper reports an extension of the study by Overstreet and Healy (2011). In Experiment 1 we required participants to recall item information from a missing word in each of the nine lines of the song prior to completing a reconstruction of order task. In contrast, Overstreet and Healy used a forced-choice recognition task. Recall is a more challenging task and, thus, presumably more diagnostic because it requires retrieval of the missing word from memory whereas the missing word is provided on the recognition test (but see Little, Bjork, Bjork, & Angello, 2012, for evidence that forced-choice recognition tests can also foster retrieval processes). If we replicate the results of Overstreet and Healy, then serial position functions cannot be due to the specific alternatives provided to participants, as only a blank was presented for the given missing item in each line in the present study. In Experiment 2 we examined word position within each line as well as line position within the entire song. For this purpose, we divided participants into three groups based on which item position (a word's position within each line) we manipulated (first, middle, or last). Finally, to determine the generalizability of the observed differences in semantic memory between item and order information, in Experiment 3 we repeated the procedure of Experiment 2 using two different sets of materials. Instead of the "CU Fight Song," we examined participants' memory for both the sequence of Harry Potter book titles and the lyrics of the Scooby Doo theme song.

Experiment 1

Method

Participants. Seventy-one undergraduate students from CU participated. All participants were enrolled in an introductory psychology course and received partial course credit for participation. All 71 students had knowledge of the “CU Fight Song” prior to participating in the experiment, as indicated by their responses to a follow-up questionnaire. An additional 57 students who had the song completely memorized prior to participating in the experiment, as determined by the questionnaire, were tested but not included in the analyses.

Design. The repeated measures factorial design included within-subjects factors of task (item vs. order) and line serial position (1-9). The proportion of correctly recalled items and the proportion of correctly placed lines were the dependent variables examined.

Materials. The official lyrics to the “CU Fight Song” (see Appendix A) were used. Each line was typed in Cambria, 12-point font with one word taken out and replaced by a blank space. The blank word was the same as the missing word in Experiment 2 of the study by Overstreet and Healy (2011). Each line was printed on standard computer paper and then cut into individual slips (approximately 2 x 6 in.) so the lines could be given to participants one at a time and then be used in the order reconstruction task.

At the end of the experiment, participants were given a brief follow-up questionnaire that asked them if they had had previous knowledge of the “CU Fight Song” and if they had memorized the song.

Procedure. Participants were first told that the experiment involved assessing their memory of the "CU Fight Song." They were given verbal instructions to write in the blank space the word (item) that they believed correctly completed each line.

After the participants had completed the item recall task, they were asked to take the nine lines of the song and reconstruct them into the correct order to the best of their ability. They used the same nine slips of paper that they had been given during the first task for reconstructing the order of the lines, so that they had access to the words they had supplied during the item recall task.

The lines were given to the participant for the item recall task in a predetermined pseudorandom order. After an initial randomized order was created, nine orders were created by rotating through the list until each line had occurred in each position. For example, the first randomized order was line 3, 4, 1, 2, 9, 5, 8, 6, 7; then the second order started with the second line from the initial order and the first line was moved to the end (4, 1, 2, 9, 5, 8, 6, 7, 3); the third randomized order in this case started with line 1, and this procedure repeated until the last line of the initial order was rotated through to be the first on the list. In addition, nine versions were created using the reverse of these nine orders. Thus, for each initial randomized order, a total of 18 pseudorandomized orders were created so that each student was given the lines in a unique order.

Students were tested individually and were allowed to take as much time as they needed. After participants finished reconstructing the order they were given the follow-up questionnaire.

Results

Separate analyses were performed for the two tasks: reconstruction of order and item recall. In addition, an overall analysis compared the two tasks. Each separate analysis was a one-way repeated measures analysis of variance (ANOVA) with the single factor of line position (with nine levels). The overall analysis consisted of a repeated measures 2 x 9 factorial ANOVA with the within-subjects factors of task and line position. Only the effects of task are summarized here for the overall analysis. Because the extent and magnitude of the primacy and recency effects vary considerably across studies, Fisher's PLSD post hoc comparisons were used to evaluate significant effects of serial position.

Order reconstruction. The main effect of line position was significant in the order reconstruction task, $F(8,560) = 13.814$, $MSE = 0.119$, $p < .0001$, $\eta^2 = .165$. This function (see Figure 1 top panel) demonstrates both primacy and recency effects. By Fisher's PLSD post hoc comparisons with alpha = .05, the primacy effect was limited to the first position; Position 1 was significantly higher than Positions 2, 3, 4, 5, and 6. The recency effect was evident for the last three positions, with Position 9 higher than Position 7, and all three of the last positions (Positions 7, 8, and 9) higher than all of the previous positions (Positions 1-6) except Position 1, which was only lower than Position 9.

Item recall. The main effect of line position was also significant in the item recall task, $F(8, 560) = 15.339$, $MSE = 0.090$, $p < .0001$, $\eta^2 = .180$; however, this effect did not reflect a bow-shaped curve that would indicate primacy as well as recency advantages. A recency advantage did occur, but there was no primacy advantage (see

Figure 1 top panel). By Fisher's PLSD test with alpha = .05, the recency effect extended to the last three positions, Positions 7, 8, and 9, which did not differ from each other but all showed significantly higher performance than Positions 1, 3, 5, and 6. (All other paired comparisons were significant except for Positions 1 and 3, 1 and 5, 2 and 4, 2 and 6, 2 and 8, 3 and 5, 4 and 6, and 4 and 8.)

Overall. Students performed significantly better overall on the item recall task (M = .814) than the order reconstruction task (M = .603), $F(1, 70) = 17.508$, MSE = 0.815, $p < .0001$, $\eta^2 = .200$. The interaction of task and line position was significant, $F(8, 560) = 6.346$, MSE = 0.105, $p < .0001$, $\eta^2 = .083$. Although both item and order tasks showed recency effects, only the order task showed a primacy effect (see Figure 1 top panel).

The results of Experiment 1 replicated those reported by Overstreet and Healy (2011, Experiment 2) despite the change from forced-choice recognition to "fill in the blank" recall. Only tests of order information resulted in a serial position function with both primacy and recency effects; tests of item information did produce recency effects but no evidence of primacy. This outcome is predicted both by perturbation theory and by SIMPLE. For the former, the first and last positions provide boundaries beyond which the items cannot drift or perturb, thereby producing primacy and recency. For the latter, the first and last positions benefit from having no neighbors on one side.

Experiment 2

Experiment 2 followed the same procedure as that of Experiment 1; however, we altered the stimuli to examine serial position within each line (as well as line position within the song). Participants were given the lines of the song on nine separate slips of paper with one of the three word positions removed (first, middle, or last). Therefore, depending on the participants' condition, they had to recall an item from the same word position for all nine lines. Once they completed the item recall task for all nine lines, they were asked to reconstruct them into the correct order.

Method

Participants. One hundred and forty-two undergraduate students from CU participated. All participants were enrolled in an introductory psychology course and received partial course credit for their participation. All 142 students had knowledge of the "CU Fight Song" prior to participating, as indicated by their responses to the follow-up questionnaire. Participants were divided into one of the three conditions, which resulted in 49 for the first, 46 for the middle, and 47 for the last word position removed from each line. An additional 74 participants who had the song completely memorized prior to participating, as determined by responses to the questionnaire, were tested but not included in the analyses.

Design. A mixed factorial design was used with the within-subjects factors of task (item vs. order) and line position (1-9) and the between-subjects factor of word position in the line (first, middle, or last).

Materials. Each line of the "CU Fight Song" was typed in Cambria, 12-point font with the first, last, or a middle word removed and replaced by a blank space (see Appendix A).

Procedure. The procedure was equivalent to that used in Experiment 1. In the item recall task, for each randomized order of the nine lines of the "CU Fight Song," three versions were given to separate groups of participants (with the first word removed from each line, middle word removed, or last word removed).

Results

Separate analyses were performed for the two tasks: reconstruction of order and item recall. The analysis for each task consisted of a 3 x 9 mixed factorial ANOVA with the between-subjects factor of word position and the within-subjects factor of line position. In addition, an overall 3 x 2 x 9 mixed factorial ANOVA compared the order and item tasks on the proportion of correct responses. Only the effects and interactions involving the factor of task are summarized for the overall ANOVA.

Order reconstruction. Analyzing the proportion of correctly placed lines in the order reconstruction task indicated that the main effect of line position was significant, $F(8, 1112) = 23.119$, $MSE = 0.114$, $p < .0001$, $\eta^2 = .143$. The function (see Figure 1 bottom panel) shows both primacy and recency effects with the best performance occurring on the first and last lines. By Fisher's PLSD post hoc comparisons with alpha = .05, the primacy effect was limited to the first line; Line 1 was significantly higher than Lines 2, 3, 4, 5, and 6. The recency effect was evident for the last three lines, with Line 9 higher than Lines 7 and 8, and all three of the last lines (Lines 7, 8, and 9) higher than all of the previous positions except Line 1, which was only lower than Line 9. In addition, Line 6 was higher than Lines 3, 4, and 5, suggesting that the recency effect might include four, not just three, lines. It is worth noting that the serial position function for the order reconstruction task (shown in Figure 1 bottom panel) is highly similar to that for the same task in Experiment 1 (shown in Figure 1 top panel) (except for the possible extension of the recency effect to four, rather than three, lines in Experiment 2, but not in Experiment 1), suggesting that the differences in missing words between the two experiments did not substantially affect order reconstruction performance.

The particular words that were missing did, nevertheless, affect order reconstruction performance. The main effect of word position was significant for the order reconstruction task, $F(2, 139) = 14.149$, $MSE = 0.987$, $p < .0001$, $\eta^2 = .169$. Performance was best for participants who were required to recall the first item in each line (see Figure 2). By Fisher's PLSD test with alpha = .05, there were differences between the first and middle positions and between the first and last positions but not between the middle and last positions. By intuition, the first word of a line might be most important for accessing the line. It is unclear then why removing the first word from every line (and requiring participants to fill it in) would yield the highest accuracy for reconstructing the order of the lines, although it is possible that the process of retrieving the crucial first word of each line might promote access to information about the order of the lines. In any event, the interaction of line position and word position was also significant, $F(16, 1112) = 2.595$, $MSE = 0.114$, $p = .0006$, $\eta^2 = .036$. The interaction reflects the fact that the bow shaped serial position function for line position is much flatter when the first word is missing than when one of the other words is missing, presumably because of the high level of accuracy for the first position (see Figure 3).

Item recall. The main effect of line position was also significant in the item recall task, $F(8, 1112) = 61.323$, $MSE = 0.123$, $p < .0001$, $\eta^2 = .306$; however, this effect did not reflect a bow-shaped curve that would indicate primacy as well as recency advantages. A recency advantage did occur for the last four lines, but there was no primacy advantage, although there was a large dip in performance at the middle line (Line 5) (see Figure 1 bottom panel). By Fisher's PLSD test with alpha = .05, Lines 6, 7, 8, and 9 were all higher than Lines 1, 3, 4, and 5. In addition, all other pairs differed significantly except Lines 2 and 3, Lines 2 and 6, Lines 2 and 8, Lines 3 and 4, Lines 6 and 8, and Lines 7 and 9. Note that although both functions show recency but not primacy advantages, the specific shape of the serial position function for the item recall task (shown in Figure 1 bottom panel) is quite different from that for the same task in Experiment 1 (shown in Figure 1 top panel), presumably because of the different items that were recalled in the two cases.

Indeed, the main effect of word position (first, middle, and last) was also significant but not strong, $F(2, 139) = 3.208$, $MSE = 0.378$, $p = .0435$, $\eta^2 = .044$, reflecting slightly higher performance when the first word was missing than when a middle word was missing (see Figure 2). By Fisher's PLSD test with alpha = .05, only the difference between the first and middle positions was significant. The interaction of line position and word position (first, middle, last) was significant $F(16, 1112) = 10.429$, $MSE = 0.123$. $p < .0001$, $\eta^2 = .130$. This interaction is difficult to describe but seems to be due in part to the relatively low performance in the first four line positions when a middle word was missing (see Figure 4). Also, there appears to be a primacy effect when the last word was missing although not when the first or middle word was missing. The interaction undoubtedly reflects differences in how easy it is to recall particular words (although the word *fight* occurs three times as the first word, three times as the middle word, and twice as the last word, with different levels of accuracy in each case). The interaction might also reflect to some extent the ability of students to guess a missing word when they had no memory for it, although, as mentioned in the Introduction, the earlier comparison by Overstreet and Healy (2011) of experimental participants (who had knowledge of the song) and control participants (who had no knowledge) suggests that guessing has at most a minor influence on the serial position functions of experimental participants.

Overall. Students performed significantly better overall on the item recall task (M = .689) than the order reconstruction task (M = .545), $F(1, 139) = 43.151$, MSE = 0.321, $p < .0001$, $\eta^2 = .237$. Importantly, the two tasks yielded different average line position functions, reflecting a recency advantage for each task but a primacy advantage only for the order reconstruction task (see Figure 1 bottom panel); the interaction of task and line position was significant, $F(8, 1112) = 24.249$, MSE = 0.106, $p < .0001$, η^2 = .149. The interaction of task and word position was also significant, $F(2, 139) = 12.026$, MSE = 0.321, $p < .0001$, $\eta^2 = .148$. The function for word position within a line was much flatter for the item task than for the order task; for the order task there was a primacy effect but no recency effect (see Figure 2). This is a puzzling finding because by intuition the missing word should have a larger impact on the item task (where the missing word must be provided) than on the order task (where entire lines must be put in sequence). Although the perturbation model is consistent with the finding that the serial position function is more pronounced for order than for item information and that a serial position function is evident for order information at different levels of the hierarchical structure of the song (see Lee & Estes, 1981), it is difficult to see how the perturbation model could account for a primacy effect but no recency effect in the function for words within a line because the perturbation process is assumed to be symmetrical at each level of the hierarchy. The same is true for SIMPLE.

Having said that, there is one possible explanation. There is a fairly consistent finding that when output begins with the first few items, primacy tends to be larger than recency, but when output begins with the last few items, recency tends to be larger than primacy (Ward, Tan, & Grenfell-Essam, 2010). One possibility is that for this particular order reconstruction task, the participants ran through the song from beginning to end and used this output direction more often for the order reconstruction task than for the item recall task. If this were the case, then both the perturbation and SIMPLE theories would be able to account for the pattern. For perturbation theory, this type of output could allow for more perturbations or drifting of items at the end than for items at the beginning, with a similar idea for SIMPLE. Although this is a conjecture and was certainly not predicted, it is consistent with the larger literature on position effects.

Finally, there was a significant three-way interaction of task, line position, and word position, $F(16, 1112) = 5.199$, $MSE = 0.106$, $p < .0001$, $\eta^2 = .070$, reflecting the fact that the first missing word had an advantage over the other missing words at all line positions for order reconstruction (see Figure 3) but not for item recall (see Figure 4).

Despite the complexity of the details, the larger findings are consistent with those of Experiment 1 and those of Overstreet and Healy (2011): There is clear evidence that item and order information differ in how they are retained in semantic memory.

Experiment 3

Experiment 3 followed the same general procedure as that of Experiment 2 with two new sets of materials. To determine the generalizability of the results of Experiment

2 for participants' memory of the "CU Fight Song," participants' memory for two other sets of materials was explored. First, the sequence of Harry Potter book titles was examined (see Kelley et al., 2013). The book titles all follow a similar format, "Harry Potter and the X Y" (with sometimes a function word or two between X and Y). This constraint affords a controlled look at two positions, the penultimate and the final content word positions. Second, the Scooby Doo cartoon theme song lyrics were examined. The purpose of using these materials was to try to test more positions within a list than was possible with the Harry Potter book titles. These Scooby Doo lyrics were chosen because they have previously given rise to semantic serial position functions (see also Kelley et al., 2013). However, because of the nature of the lyrics, we were unable to systematically manipulate the position of the missing word in each line of the lyrics and therefore for these materials comparable analyses to those reported in Experiment 2 are not without problems.

Participants were given the complete list of titles for the Harry Potter books and the complete set of lyrics for the Scooby Doo song during the order reconstruction task, with no words missing from the titles or lyrics. The reason for this change in procedure was the finding in Experiment 2 that the position of the missing word affected order reconstruction as well as item recall. It seems likely that word position influenced the order reconstruction task because participants saw only the missing words they filled in, not necessarily the correct words, in the order reconstruction task (i.e., performance on the item recall task might have contaminated performance on the order reconstruction task). Thus, word position should have a smaller effect on order reconstruction in

Experiment 3 when participants are provided with the complete titles and lyrics on which to perform the reconstruction task.

Method

Participants. Seventy-one undergraduate students from CU participated along with one volunteer who was a college graduate. The CU participants were enrolled in an introductory psychology course and received partial course credit for their participation. The 72 participants were divided into eight counterbalancing conditions according to a fixed rotation.

Design. Participants performed an item recall task followed by an order reconstruction task for each set of materials (Harry Potter books and Scooby Doo lyrics), with the two sets of materials tested in a counterbalanced order. Half of the participants in each material order group received one version of the Harry Potter list (List A or List B), and the other half of the participants received the other list. Likewise, half of the participants in each material order and Harry Potter list received one version of the Scooby Doo list (List 1 or List 2), and the other half of the participants received the other list. There were, thus, eight counterbalancing groups of participants with nine participants in each group. For each set of materials, a mixed factorial design was used with the within-subjects factors of task (item vs. order) and line position (1-7 for Harry Potter and 1-8 for Scooby Doo) and the between-subjects factor of item list (List A vs. B for Harry Potter and List 1 vs. 2 for Scooby Doo).

Materials. The two lists used for the Harry Potter books are shown in Appendix B, and those for the Scooby Doo lyrics are shown in Appendix C. Each line was typed in Helvetica, 10-point font with the highlighted word removed and replaced by a blank space for the item recall task. Each line was printed on standard computer paper and then cut into individual slips (approximately 2 x 6 in.) so the lines could be given to participants one at a time for the item recall task. The highlighted words were not removed for the order reconstruction task, but otherwise the construction of individual slips for each line was the same.

At the end of the experiment, participants were given a brief questionnaire that included each of the following two questions: “Prior to this experiment, have you ever *heard* the Scooby Doo lyrics?” and “Prior to this experiment, were you familiar with the Harry Potter book titles?”

Procedure. Participants were told that the experiment involved assessing their memory of the Harry Potter book titles and Scooby Doo song lyrics. For each set of materials, they were given verbal instructions for the item recall task to complete each of the seven or eight lines by writing in the blank space what they believed to be the correct word. After completing the item recall task, participants were given the seven or eight slips of paper for the order reconstruction task (with no missing words) and put the slips in the order in which they appeared in the chronology or song.

For the item recall task, the seven or eight lines were handed to participants in a random order determined by shuffling the slips of paper. Separate shuffling was done for each participant and each task, so different orders were used for the item recall and order reconstruction tasks for a given participant.

Results

For each set of materials, separate analyses were performed for the two tasks, reconstruction of order and item recall. The analysis for each task consisted of an

ANOVA with the between-subjects factor of item list and the within-subjects factor of line position. In addition, an overall ANOVA compared the order and item tasks on the proportion of correct responses. Only the effects and interactions involving the factor of task are summarized here for the overall ANOVA. All of these analyses for a given set of materials were restricted to those participants who had prior familiarity with the list (e.g., they responded "yes" to the question, "Prior to this experiment, were you familiar with the Harry Potter book titles?"). A final overall ANOVA comparing the order and item tasks was conducted that also compared those individuals with prior familiarity to those with no prior familiarity with the list. Thus, along with the within-subjects factors of line position and task, this ANOVA included the between-subjects factor of prior familiarity (yes, no). For that analysis only the effects and interactions involving the new factor of prior familiarity are summarized here. The participants with no prior familiarity with the list serve as a valuable control to determine whether any serial position effects are artifacts of the sequence of list items.

Harry Potter.

Order reconstruction. An analysis of the proportion of correctly placed lines in the order reconstruction task for the Harry Potter books indicated a significant main effect of line position, $F(6, 372) = 3.741$, $MSE = 0.115$, $p = .0013$, $\eta^2 = .057$. The function (see Figure 5) shows an extended four-position primacy effect and perhaps a more modest one-position recency effect. By Fisher's PLSD post hoc comparisons with alpha = .05, Line 1 was higher than Lines 5, 6, and 7, and Lines 2, 3, and 4 were all higher than Lines 5 and 6. The item list (List A in which the penultimate content word was missing or List B in which the final content word was missing) did not affect performance; neither the main effect of item list nor the interaction of line position and item list was significant, $F < 1$ in each case. This lack of an effect of item list on order reconstruction was expected because there were no missing words in that task, unlike in Experiment 2, where the lines given to the participants for order reconstruction included the missing words filled in by the participants in the item recall task.

Item recall. There was also a significant main effect of line position for item recall, $F(6, 372) = 2.268$, $MSE = 0.057$, $p = .0366$, $\eta^2 = .035$. However, the function is flatter than that observed for the order reconstruction task, with only modest primacy and recency effects evident (see Figure 5). By Fisher's PLSD post hoc comparisons, only Lines 1 and 2 were higher than Line 5, and Line 2 was also higher than Line 6. The effect of line position depended on item list; the interaction of line position and item list was significant, $F(6, 372) = 3.175$, $MSE = 0.057$, $p = .0047$, $\eta^2 = .049$, because the bow shape was due entirely to List A; List B showed high performance at all line positions, so participants did better at recalling the end of a title than the earlier part of a title, at least for the four last line positions (see Figure 6).

Overall. There was a main effect of task, $F(1, 62) = 20.775$, $MSE = 0.221$, $p < .0001$, $\eta^2 = .251$, reflecting lower performance on order reconstruction (.732) than on item recall (.879). No interactions involving task were significant, although the interaction of task and item list approached significance, $F(1, 62) = 3.941$, $MSE = 0.221$, $p = .0516$, $\eta^2 = .060$, because item recall was more affected by item list (List A = .833, List B = .920) than was order reconstruction (List A = .752, List B = .714) and in the opposite direction. For the other interactions with task, $F(6, 372) \leq 1.350$, $p \geq .2342$.

Prior familiarity. Among the 72 participants, there were 64 with prior familiarity with the Harry Potter books and only 8 with no prior familiarity. Participants having prior familiarity with the Harry Potter books naturally performed better overall (.806) than those with no prior familiarity (.402), $F(1, 70) = 19.215$, $MSE = 0.846$, $p < .0001$, $\eta^2 = .215$. Prior familiarity with the books had a much larger effect on the item recall task (no = .339, yes = .879) than on the order reconstruction task (no = .464, yes = .732); the interaction of task and prior familiarity was significant, $F(1, 70) = 6.441$, $MSE = 0.287$, $p = .0134$, $\eta^2 = .084$. The serial position functions for the item and order tasks both depended on prior familiarity; the three-way interaction of line position, task, and prior familiarity was significant, $F(6, 420) = 2.789$, $MSE = 0.082$, $p = .0114$, $\eta^2 = .038$ (see Figure 7). Note in particular that the bow-shaped serial position function for the reconstruction of order task found with participants having prior familiarity is not evident with participants having no prior familiarity with the Harry Potter books, suggesting that the function is due to semantic memory processes rather than to guessing.

As in the other experiments, there were again differences as a function of item vs. order information. When tested for order information, primacy and recency effects were again observed (although the recency effect was modest), and there was no effect of item list on order information. In contrast, when item information was tested, the serial position curve was flatter, and there was an interaction with the particular item list.

Scooby Doo.

Order reconstruction. An analysis of the proportion of correctly placed lines in the order reconstruction task for the Scooby Doo lyrics indicated a significant main effect of line position, $F(7, 448) = 6.042$, $MSE = 0.134$, $p < .0001$, $\eta^2 = .086$. The function (see

Figure 8) shows a large primacy advantage for Line 1 and a smaller advantage for Lines 3 and 4. By Fisher's PLSD post hoc comparisons with alpha = .05, Line 1 was higher than all the other lines (Lines 2-8), Line 3 was higher than Lines 5, 6, and 8, and Line 4 was higher than Lines 5 and 6. The item list (List 1 or List 2) did not affect performance; neither the main effect of item list, $F(1, 64) = 1.139$, $MSE = .682$, $p = .2900$, $\eta^2 = .017$, nor the interaction of line position and item list, $F(7, 448) < 1$, were significant.

Item recall. There was also a significant main effect of line position for item recall, $F(7, 448) = 30.404$, $MSE = 0.135$, $p < .0001$, $\eta^2 = .322$. However, the function is different from that observed for the order reconstruction task, although it also shows a primacy effect (see Figure 8). By Fisher's PLSD post hoc comparisons, all lines differed from each other except Lines 1 and 2, 1 and 7, 2 and 7, 3 and 4, 3 and 6, 4 and 6, 4 and 8, and 5 and 8. The effect of line position depended on item list; the interaction of line position and item list was significant, $F(7, 448) = 13.998$, $MSE = 0.135$, $p < .0001$, $\eta^2 = .179$, because the two item lists showed very different patterns (see Figure 9). The main effect of item list was significant as well, $F(1, 64) = 24.136$, $MSE = 0.325$, $p < .0001$, $\eta^2 = .274$, reflecting overall higher performance on List 2 (.662) than on List 1 (.418).

Overall. There was a main effect of task, $F(1, 64) = 49.424$, $MSE = 0.317$, $p < .0001$, $\eta^2 = .436$, again reflecting lower performance on order reconstruction (.297) than on item recall (.544). All interactions involving task were also significant, including the interaction of task and item list, $F(1, 64) = 5.807$, $MSE = 0.317$, $p = .0189$, $\eta^2 = .083$, because item recall was more affected by item list (List 1 = .418, List 2 = .662) than was order reconstruction (List 1 = .258, List 2 = .335). Also, the interaction of task and line position was significant, $F(7, 448) = 12.907$, $MSE = 0.130$, $p < .0001$, $\eta^2 = .168$, as was the three-way interaction of task, line position, and item list, $F(7, 448) = 6.371$, $MSE = 0.130$, $p < .0001$, $\eta^2 = .091$. These interactions reflect for order reconstruction a bowed function (with large primacy and perhaps small recency) that is fairly consistent across the two item lists but for item recall more jagged functions that are quite different for the two item lists (see Figure 10).

Prior familiarity. Among the 72 subjects, there were 66 with prior familiarity with the Scooby Doo lyrics and only six with no prior familiarity. On the item recall task subjects having prior familiarity with the Scooby Doo lyrics naturally performed better (.544) than subjects with no prior familiarity (.271), but performance on the reconstruction of order task was no worse for those with no prior familiarity (.333) than for those with prior familiarity (.297); the interaction of task and prior familiarity was significant, $F(1, 70) = 6.222$, $MSE = 0.337$, $p = .0150$, $\eta^2 = .082$. No other effects involving prior familiarity were significant, suggesting that the serial position effects found for the Scooby Doo lyrics might be artifacts of the specific list items rather than effects of semantic memory processes, although this conclusion should be accepted with caution because only six participants indicated that they were not familiar with the lyrics.

Despite the complexity of the results, there is consistent evidence that item and order information differ when recalling knowledge from semantic memory, regardless of whether the knowledge involves book titles, cartoon lyrics, or a college fight song.

General Discussion

In both Experiments 1 and 2 of the present study, which involved memory for the "CU Fight Song," the main effect of line position was significant for the order reconstruction task and reflected both primacy and recency effects, whereas analysis of this feature in the item recall task also yielded a significant main effect but did not yield a bow-shaped serial position curve like that of the order task because a recency effect but no primacy effect was evident. These findings suggest that the pronounced bow-shaped serial position function in semantic memory occurs largely because of the retention of order, rather than item, information. These results concerning memory for the "CU Fight Song" generalize by and large to those for two other sets of materials, the sequence of Harry Potter book titles and the Scooby Doo theme song lyrics, because the primacy and recency effects were more consistent for order reconstruction than for item recall in Experiment 3 (although the serial position functions for order reconstruction exhibited a more extensive primacy effect in Experiment 3 and a more extensive recency effect in Experiments 1 and 2).

The item recall task in Experiment 2 was expanded to study further students' retention of item information by examining serial position within each line. We found evidence of primacy in the order reconstruction task, but a much flatter function in the item recall task, once again indicating that the serial position curve is a result of order information and not the result of item information. Whereas all three groups demonstrated a bow-shaped line position curve in the order reconstruction task, the groups varied in their level of accuracy. The three word positions had a much smaller (but still significant) impact on students' recall of item information. However, only performance on the order reconstruction task strongly differed based on the position of the missing words. Those students who were required to recall the first word of each line performed significantly better in the order reconstruction task than those who had a middle or end word missing. Why there was a strong advantage for order reconstruction when the first item was recalled is an open and puzzling question. Nevertheless, it was clearly not a matter of the first words being easiest to recall because the effect of word position was much smaller for the item recall task. Therefore we can infer that the serial position function for item information shows less primacy than that for order information, whether the item positions considered are for lines within the song or for words within the lines.

The results of Experiment 3, which involve two different sets of materials (the sequence of titles for the Harry Potter books and the lyrics for the Scooby Doo song) throw some light onto these observation because in that experiment participants completed the order reconstruction task with all of the lines intact. Unlike Experiments 1 and 2, there were no missing words in the order reconstruction task in Experiment 3. Consequently, in Experiment 3, there was no effect of item list on order reconstruction for either the Harry Potter book titles or the Scooby Doo lyrics; item list only affected item recall (because it was easier to recall the last content word of a Harry Potter book title than the penultimate content word at least for the last four line positions in the sequence and the items in List 2 of the Scooby Doo Lyrics were generally recalled better than those in List 1, with the two lists showing different serial position functions). Thus, the effect of word position on order reconstruction in Experiments 1 and 2 can be attributed at least in part to the fact that participants' memory for the missing words in the lines influenced their ability to reconstruct the order of the lines, so the order reconstruction task was not fully distinguishable from the item recall task in those experiments (see Nairne & Kelley, 2004, for a discussion of other problems involving "process purity" in distinguishing item from order information).

The “CU Fight Song” is mostly sung while the school band plays instruments. The song has its own melody and rhythm, with most lines having a different melody except that lines 2 and 6 share the same melody. It is likely that listening to the music of the song would enhance memory performance for the song, given the integration effect found in earlier studies (e.g., Crowder, Serafine, & Repp, 1990; Kilgour, Jakobson, & Cuddy, 2000), by which memory for the lyrics of a song is enhanced by the presence of the song’s melody. Of interest in future studies would, therefore, be whether music would have a facilitating effect on both order reconstruction and item recall tasks for the “CU Fight Song” and the Scooby Doo theme song as well as for other songs.

The first two experiments in the present study, like the early ones by Overstreet and Healy (2011), are focused on a single song. Some of the details of the serial position effects in those experiments are undoubtedly due to the specific lines and words included in this single song and the ability of participants to guess the missing words when they have no memory for them, just as some of the findings in the pioneering study of Roediger and Crowder (1976) reflect the idiosyncrasies of the list used in that case. As mentioned in the Introduction, however, the previous experiments by Overstreet and Healy (2011), which included control participants who did not know the words of the “CU Fight Song,” showed different serial position functions for experimental and control participants, thereby indicating that guessing was unlikely as the cause for the observed serial position functions. Furthermore, the third experiment in the present study was able to replicate the results differentiating the serial position functions for item and order information using the same procedures on different stimulus content (i.e., the sequence of Harry Potter books titles and the Scooby Doo song lyrics). The bowed serial position functions for order information in semantic memory were also replicated in earlier studies with different stimulus content, including the Harry Potter book titles and Scooby Doo song lyrics (e.g., Kelley et al., 2013). However, these earlier studies using different stimulus content did not examine tests of item information; they only involved tests of order information.

The present study has, thus, extended the generality of the earlier findings by Overstreet and Healy (2011), demonstrating that the differences between item and order information were not due to the specific choices given to participants in the previous test of item information. The same differences were found in the present study when participants filled in blank spaces in the item test and were found for three different word locations in each line of the "CU Fight Song," and in two different word locations in the sequence of Harry Potter book titles, not just a single location. Differences in the retention of item and order information have been used to provide critical tests of theories of episodic memory (see, e.g., the study of Beaman & Jones, 1997, who compared item and order tasks to discriminate between alternative models of the irrelevant speech effect). Likewise, differences in the retention of item and order information, like that found in the present study, might provide critical tests of theories of semantic memory and might illuminate the nature of the representations used in semantic memory.

Although there were some differences in the results of each individual experiment (and of the two sets of materials in Experiment 3), the pattern observed in all cases is that item and order information have distinguishable effects when people recall information from semantic memory. This difference, which is consistently observed in both short- and long-term episodic tasks, is predicted by two different models, perturbation theory and SIMPLE, and the models do so using the same explanatory mechanisms for both semantic and episodic tasks.

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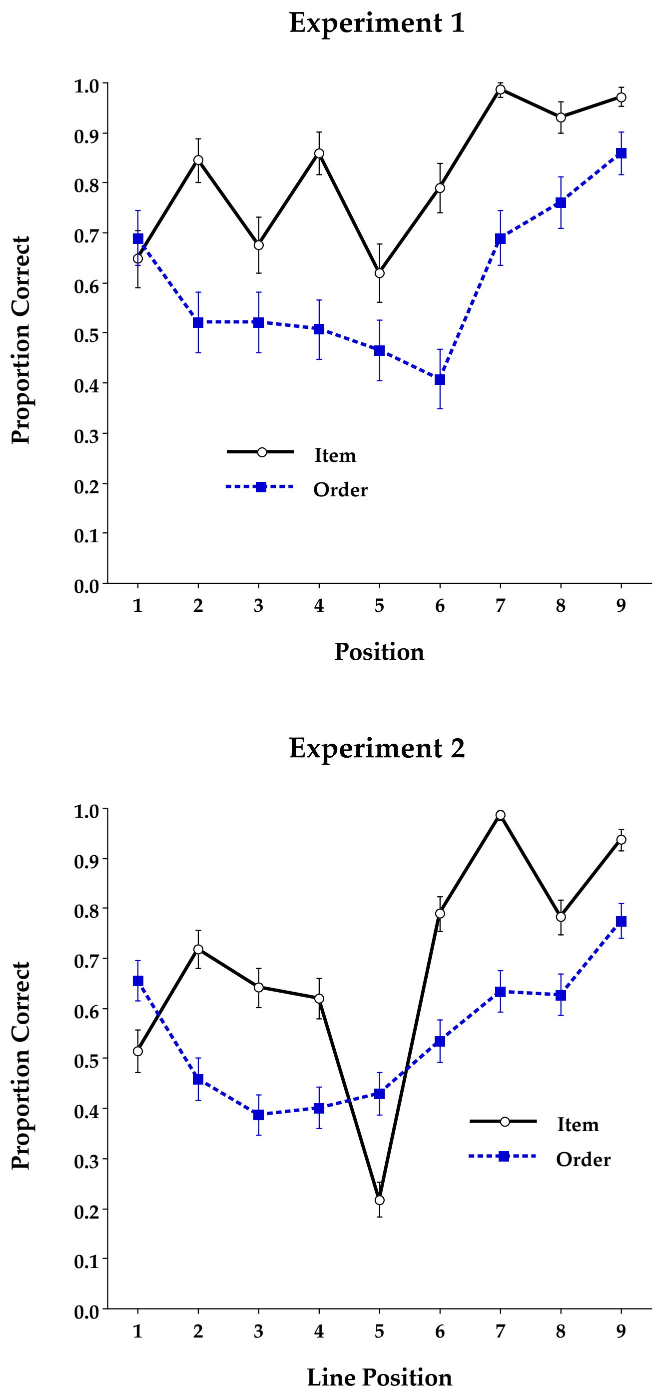


Figure 1. Proportion of correct responses on the reconstruction of order and item recall tasks in Experiment 1 (top panel) and Experiment 2 (bottom panel) as a function of line position. Error bars represent between-subjects standard errors of the means.

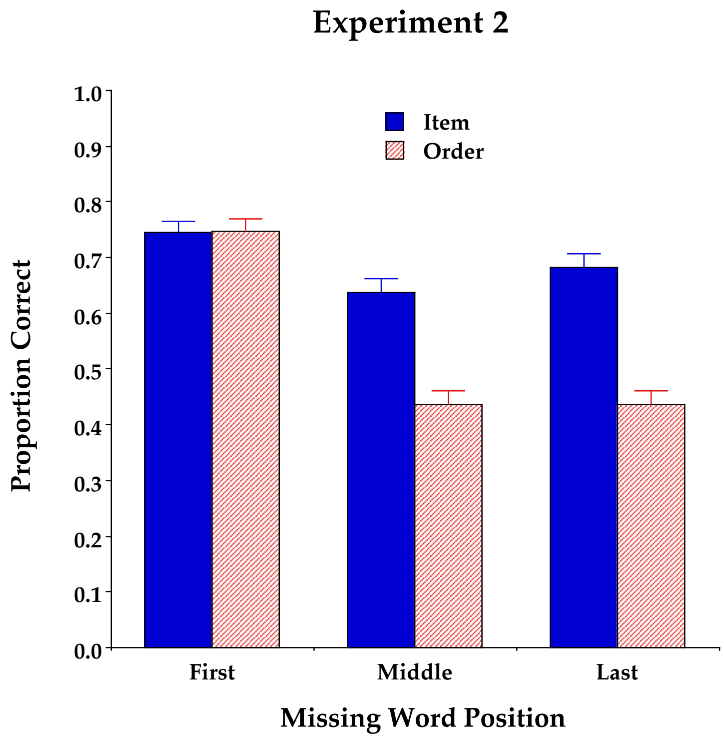


Figure 2. Proportion of correctly placed lines on the order reconstruction task and correctly recalled words on the item recall task for the three word position categories (first, middle, and last) in Experiment 2. Error bars represent between-subjects standard errors of the means.

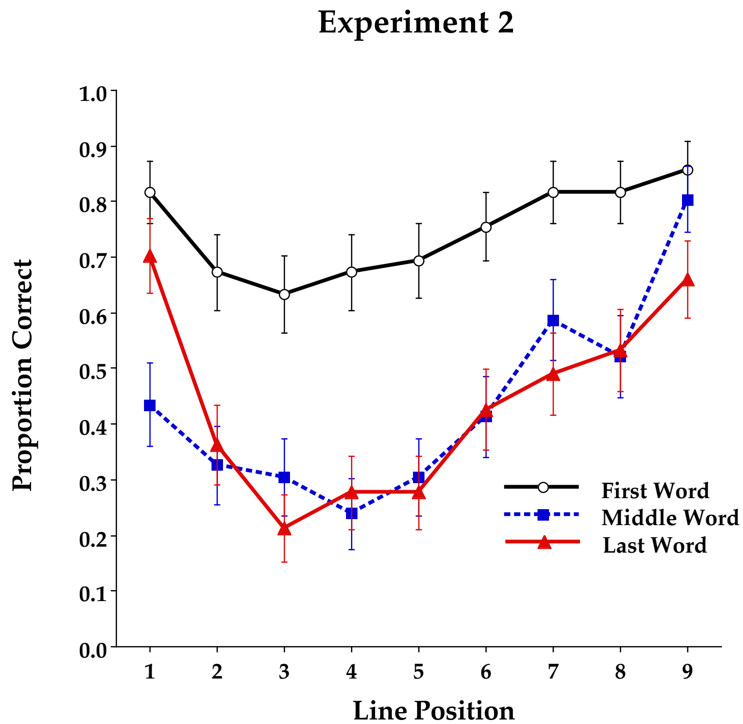


Figure 3. Proportion of correctly placed lines on the order reconstruction task in Experiment 2 as a function of line position for the three word position categories (first, middle, and last). Error bars represent between-subjects standard errors of the means.

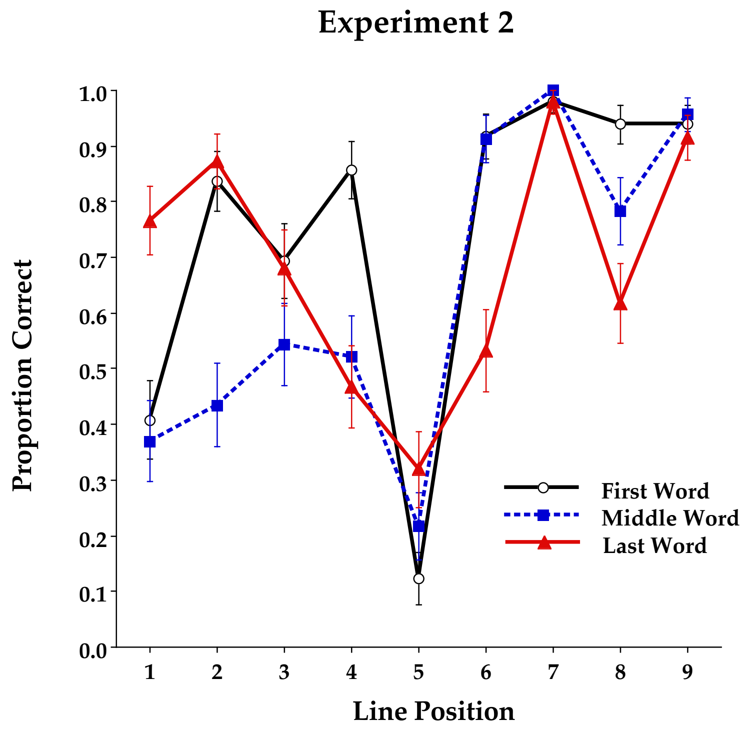


Figure 4. Proportion of correctly recalled words on the item recall task in Experiment 2 as a function of line position for the three word position categories (first, middle, and last). Error bars represent between-subjects standard errors of the means.

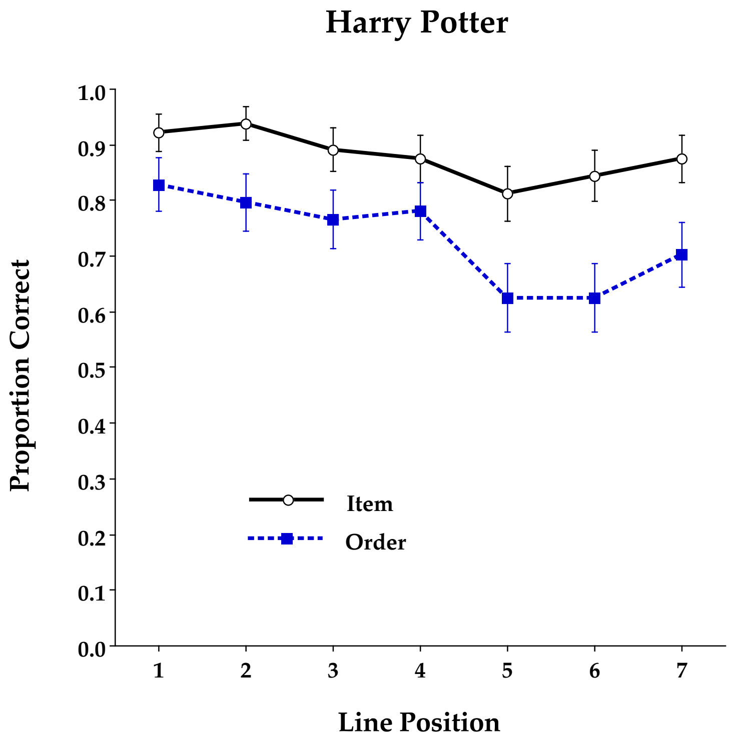


Figure 5. Proportion of correct responses on the reconstruction of order and item recall tasks for the Harry Potter materials in Experiment 3 as a function of line position. Error bars represent between-subjects standard errors of the means.

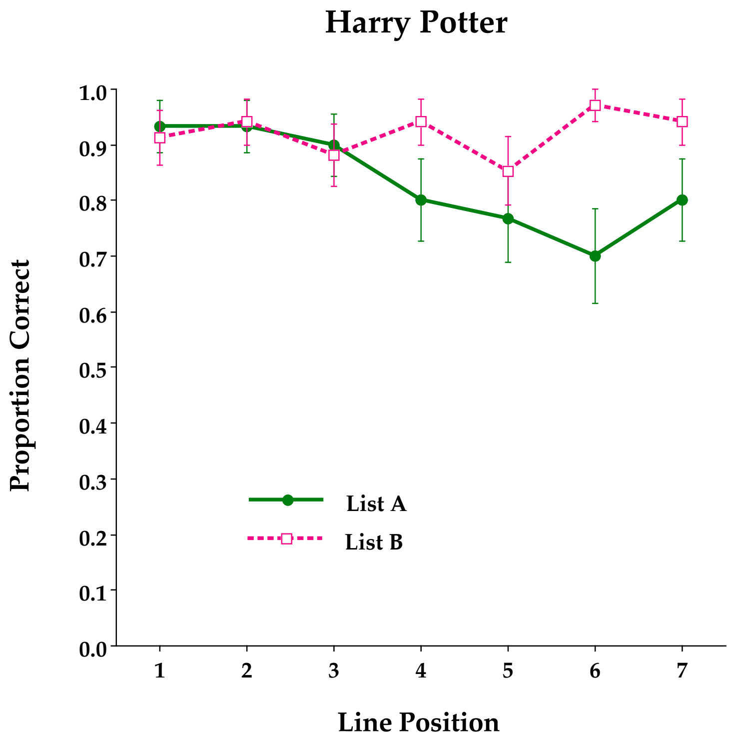
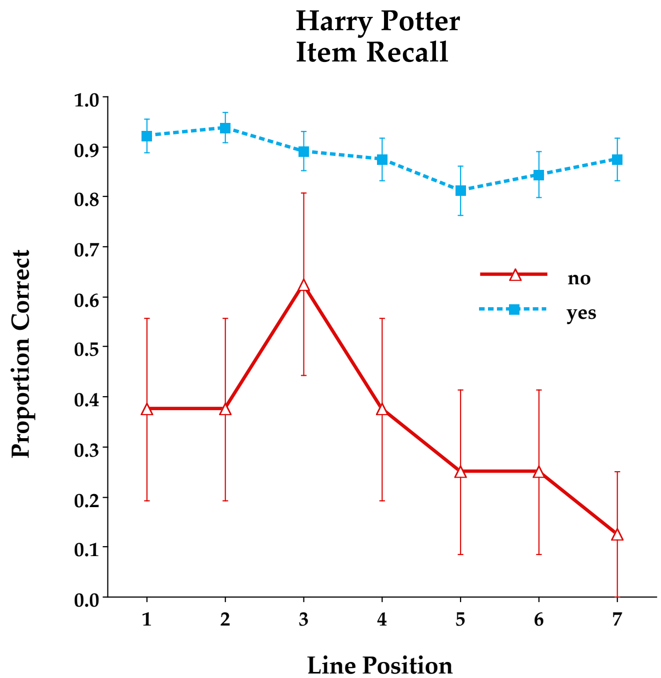


Figure 6. Proportion of correct responses on the item recall task for the Harry Potter materials in Experiment 3 as a function of line position and item list. Error bars represent between-subjects standard errors of the means.



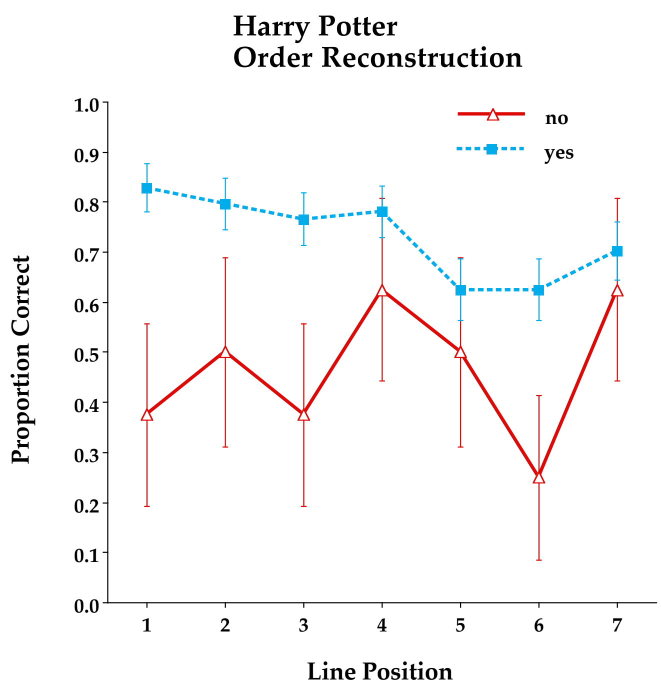


Figure 7. Proportion of correct responses on the item recall and reconstruction of order tasks for the Harry Potter materials in Experiment 3 as a function of line position and prior familiarity. Error bars represent between-subjects standard errors of the means.

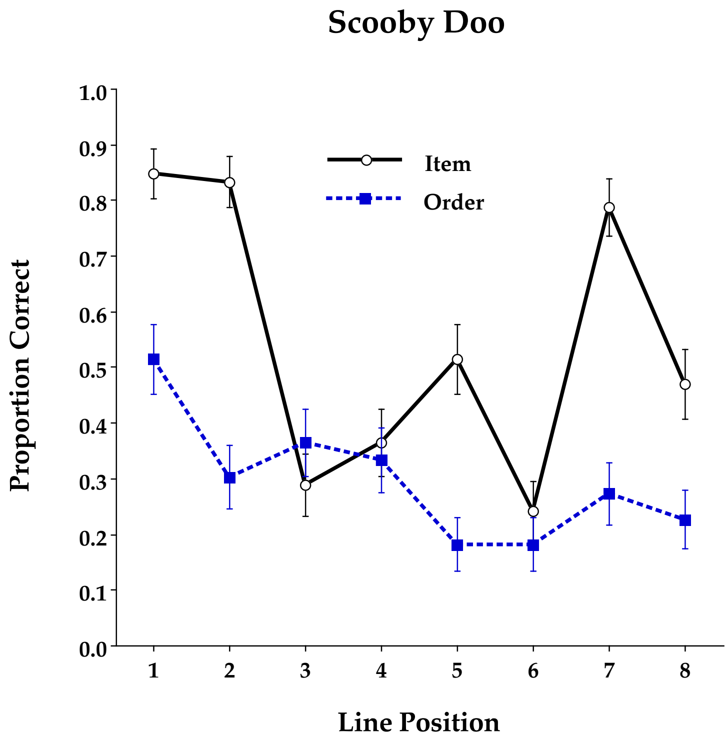


Figure 8. Proportion of correct responses on the reconstruction of order and item recall tasks for the Scooby Doo materials in Experiment 3 as a function of line position. Error bars represent between-subjects standard errors of the means.

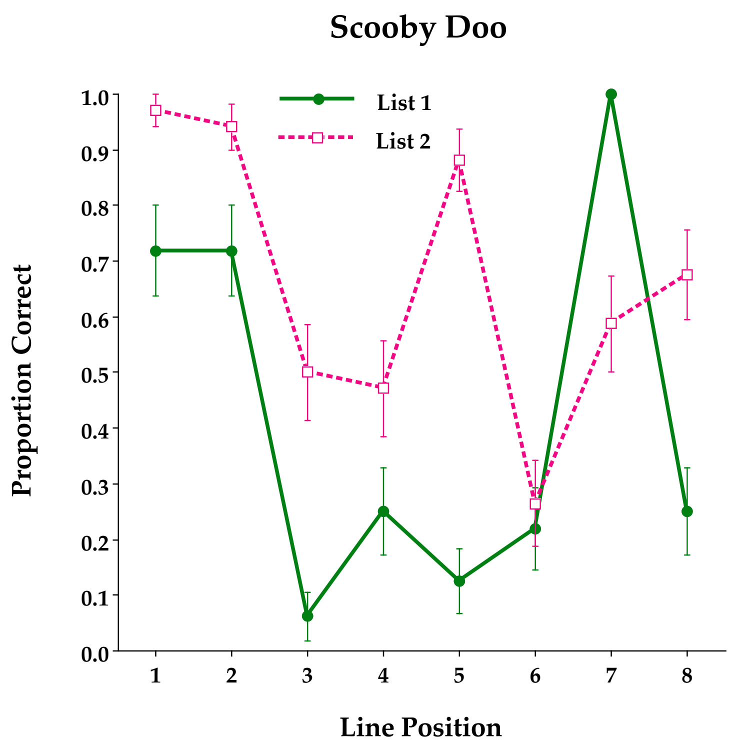


Figure 9. Proportion of correct responses on the item recall task for the Scooby Doo materials in Experiment 3 as a function of line position and item list. Error bars represent between-subjects standard errors of the means.

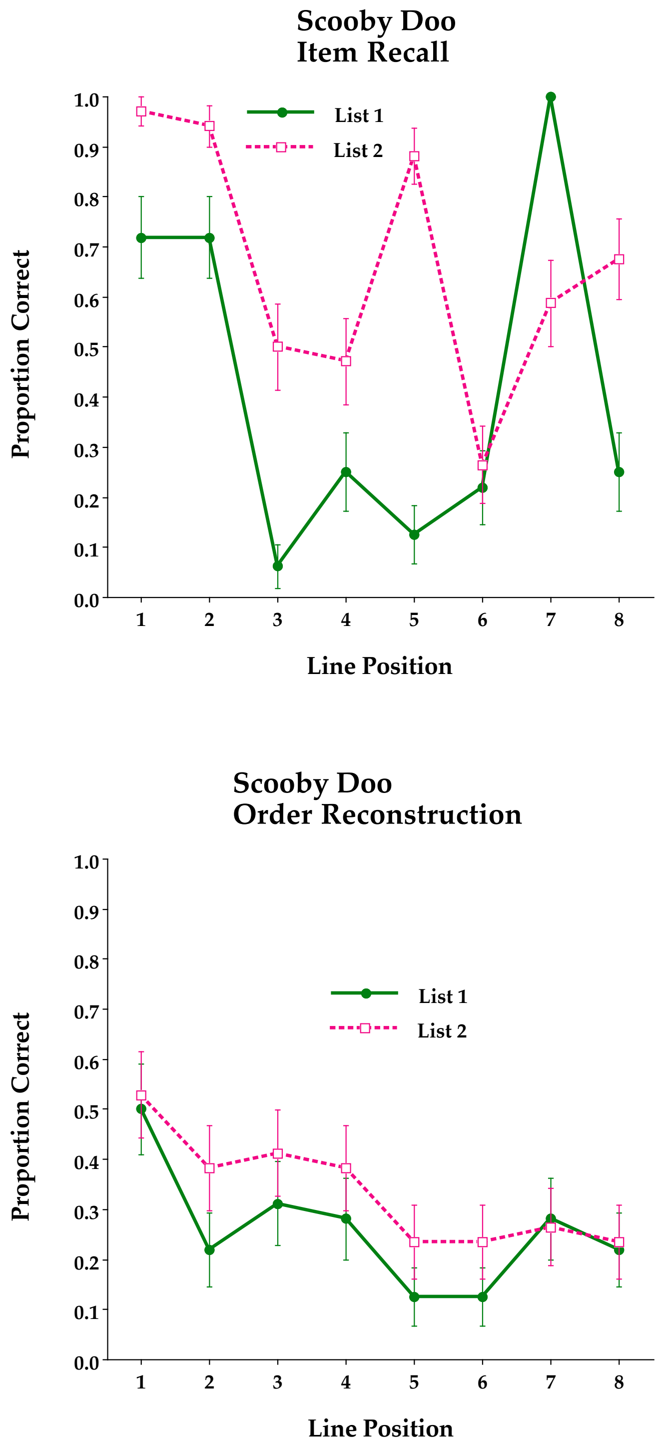


Figure 10. Proportion of correct responses on the item recall and reconstruction of order tasks for the Scooby Doo materials in Experiment 3 as a function of line position and item list. Error bars represent between-subjects standard errors of the means.

Appendix A

Lyrics to the "CU Fight Song"

1. *Fight* <u>CU</u> down the field
2. CU <u>*must*</u> win
3. *Fight*, <u>fight</u> for victory
4. CU <u>*knows*</u> no defeat
5. We'll <u>*roll*</u> up a mighty score
6. Never <u>give</u> *in*
7. Shoulder <u>*to*</u> shoulder
8. We will <u>*fight*</u>, fight
9. *Fight*, <u>fight</u>, fight

Note. Missing word in Experiment 1 is in italics. Missing middle word in Experiment 2 is underlined. Missing words are also summarized below.

Experiment 1	*First word*	*Middle word*	*Last word*
1. Fight	Fight	CU	field
2. must	CU	must	win
3. fight	Fight	fight	victory
4. knows	CU	knows	defeat
5. roll	We'll	roll	score
6. in	Never	give	in
7. to	Shoulder	to	shoulder
8. fight	We	fight	fight
9. fight	Fight	fight	fight

Appendix B

Harry Potter Books

List A:

1. Harry Potter and the *Sorcerer's* Stone

2. Harry Potter and the *Chamber* of Secrets

3. Harry Potter and the *Prisoner* of Azkaban

4. Harry Potter and the *Goblet* of Fire

5. Harry Potter and the *Order* of the Phoenix

6. Harry Potter and the *Half-Blood* Prince

7. Harry Potter and the *Deathly* Hallows

List B:

1. Harry Potter and the Sorcerer's *Stone*

2. Harry Potter and the Chamber of *Secrets*

3. Harry Potter and the Prisoner of *Azkaban*

4. Harry Potter and the Goblet of *Fire*

5. Harry Potter and the Order of the *Phoenix*

6. Harry Potter and the Half-Blood *Prince*

7. Harry Potter and the Deathly *Hallows*

Note. Missing word in the item recall task is in italics.

Appendix C

Scooby Doo Lyrics

List 1:

1. Scooby-Dooby-Doo, Where Are You? We got some *work* to do now.

2. Scooby-Dooby-Doo, Where Are You? We need some *help* from you now.

3. Come on Scooby-Doo, I see you... pretending you got a *sliver*

4. But you're not fooling me, cause I can see, the way you shake and *shiver*.

5. You know we got a mystery to solve, So Scooby Doo be ready for your *act*. Don't hold back!

6. And Scooby Doo if you come through you're going to have *yourself* a Scooby snack!

7. Scooby-Dooby-Doo, *here* Are You. You're ready and you're willing.

8. If we can count on you Scooby Doo, I know you'll catch that *villain*.

List 2:

1. Scooby-Dooby-Doo, Where Are You? We got some work to do *now*.

2. Scooby-Dooby-Doo, Where Are You? We *need* some help from you now.

3. *Come* on Scooby-Doo, I see you... pretending you got a sliver

4. But you're not *fooling* me, cause I can see, the way you shake and shiver.

5. You know we got a *mystery* to solve, So Scooby Doo be ready for your act. Don't hold back!

6. And Scooby Doo if you come *through* you're going to have yourself a Scooby snack!

7. Scooby-Dooby-Doo, here Are You. You're *ready* and you're willing.

8. If we can count on you Scooby Doo, I know you'll *catch* that villain.

Note. Missing word in the item recall task is in italics.

Comparing serial position effects in semantic and episodic memory using reconstruction of order tasks. Journal of Memory and Language, 42, 147-167.Â ^ Overstreet, Michael F.; Healy, Alice F. (16 November 2010). "Item and order information in semantic memory: students' retention of the "CU fight song" lyrics". Memory & Cognition. 39 (2): 251â€“259. doi:10.3758/s13421-010-0018-3.

University of Colorado (CU) students were tested on memory for the â€œCU Fight Songâ€ in order to examine serial position effects in semantic memory while controlling for familiarity across positions....Â Experiment 2 added a task assessing memory of item information. One word was removed and replaced with a blank in each line, and an alternative word was offered as an option, along with the correct word. Students selected the word that fit into each blank and then reconstructed the order of the lines. There was a bow-shaped curve for order reconstruction, but not for item selection, which implies that the serial position function in semantic memory stems from order, rather than item, information. Keywords. Serial position effects Memory Semantic memory. University of Colorado (CU) students were tested for both order and item information in their semantic memory for the "CU Fight Song". Following an earlier...Â Further differentiating item and order information in semantic memory: studentsâ€™ recall of words from the â€œCU Fight Songâ€, Harry Potter book titles, and Scooby Doo theme song. Michael F. Overstreet, Alice F. Healy, Ian Neath.