

Word-length Effects in Backward Serial Recall and the Remember/Know Task

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Abstract

This study tested an item-order explanation of word-length effects in backward serial recall and recognition. It examined (a) whether the superior recall for short words expected for order-based tasks, and consistently found in forward serial recall, would apply also to backward serial recall; (b) whether the superior recall for long words expected for item-based tasks would apply to recognition; and (c) whether there was evidence for qualitative differences in processing between long and short words. Twenty adults performed backward serial recall and recognition tasks based on five-word lists of short and long words. They then completed a remember/know task requiring them to classify each recognized word as being consciously recollected (remember) or as just being familiar (know). The results showed that backward serial recall was better for short words than for long words, whereas recognition was better for long words than for short words. These opposing word-length effects were consistent with the item-order explanation. The remember/know analysis showed that long words were more likely to be classified as consciously remembered than as just familiar, whereas for short words there was no difference. This suggested that long words were encoded with more episodic information than short words during initial processing.

The consistent finding that immediate serial recall is better for short words than for long words has been the cornerstone of theories of short-term memory based on trace-decay plus rehearsal (TDR) (Baddeley, Thomson, & Buchanan, 1975). These assume that phonological traces decay rapidly in a time-limited store unless refreshed by rehearsal, and that more short words than long words can be rehearsed in the limited time available before decay (Brown & Hulme, 1995). However, the assumptions of TDR have been challenged in recent years (see Nairne, 2002), and alternative explanations of this word-length effect have been proposed. The present study tests the predictions of the item-and-order account put forward by Hendry and Tehan (2005) as a potential replacement for the previously dominant TDR explanation.

This item-and-order approach derives from a study by Nairne, Riegler, and Serra (1991), who showed that

recall for serial order was impaired for words presented in a generation (word-completion) task compared with intact words, but that recognition for generated words seemed to be enhanced by the additional item processing at study. Hendry and Tehan (2005) used an analogous approach to investigate word length in different tasks and, like Nairne et al., found a dissociative effect. There was an advantage for short words in serial recall, but an advantage for long words in recognition. They interpreted these opposing word-length effects as reflecting differential processing of short and long words, such that short words were encoded with more order information to the detriment of item information, while long words were encoded with more item information at the expense of order information. Tehan and Tolan (2007) replicated these findings using several order- and item-based tasks involving both short- and long-term memory. However, the nature of this suggested differential processing has not yet been explored.

A possible method for investigating recognition is the remember/know procedure, devised originally by Tulving (1985), who showed that people could state whether they (a) consciously recollected having encountered an item ('remember'), or (b) were aware that it had been there through a general feeling of familiarity but no specific memory ('know'). This distinction has since been applied in hundreds of studies in various domains, and many variables have been found to dissociate 'remember' and 'know' responses (see Gardiner & Richardson-Klavehn, 2000). The major findings relating to item recognition suggest that 'remember' responses are boosted for items that require more effortful or elaborative processing (Gardiner & Richardson-Klavehn). Both word frequency and word generation have been shown to have this effect (Gardiner, 1988; Gregg, Gardiner, Karayianni, & Konstantinou, 2006). The remember/know procedure has not previously been applied to the study of word length in recognition, however.

Numerous studies have confirmed the word-length effect in forward serial recall (Lovatt & Avons, 2001), but very few have investigated serial recall of word lists

in reverse order. Incidental findings in studies by Cowan, Wood, and Borne (1994), and Walker and Hulme (1999), have suggested an advantage for short words in backward serial recall, but a study by Tehan and Mills (2007) found no word-length effect. The item-and-order approach would predict a short-word advantage for an order-based recall task. In view of the apparent inconsistency in previous findings, further investigation of word length in backward serial recall seemed necessary.

The present study therefore aimed to provide further evidence concerning the validity of the item-and-order approach, by examining word-length effects both in an order-based recall task and an item-based recognition task. It aimed also to extend the study of word-length effects to the case of backward serial recall. Finally, it aimed to examine the recognition responses for evidence of differential processing based on word length, and in particular for elaborated processing of long words.

The study used a backward serial recall task, a recognition task, and a remember/know task to test the following hypotheses:

1. That the proportion of words correctly recalled in serial position on the backward serial recall task would be significantly greater for short words than for long words.
2. That the proportion of words correctly recognized in the word recognition task would be significantly greater for long words than for short words.
3. That for long words recognized, a significantly greater proportion would be categorized as 'remember' than as 'know.'
4. That for short words recognized, there would be no significant difference in the proportions categorized as remember and know.

Method

Participants

Participants were 20 volunteers (12 females and 8 males) aged from 18 to 56 years ($M = 33.5$, $SD = 13.4$). All spoke English as their first language. They were offered entry to a draw for cash prizes up to \$100 in return for participating.

Materials

The three experimental tasks (backward serial recall, recognition, and remember/know) were created using 160 short words and 160 long words from the MRC Psycholinguistic Database (Coltheart, 1981). The short words were all monosyllabic with 2 to 4 phonemes. The long words had between two and five syllables, and 6 to 11 phonemes. All words were concrete nouns with a

minimum concreteness rating of 500 and a minimum frequency of five per million according to the Kucera and Francis (1967) norms. Mean frequencies were 42.8 for the short words ($SD = 42.8$), and 41.4 for the long words ($SD = 62.6$). There was no significant difference in frequency between the two word pools, $t(318) = .23$, $p = .82$.

For each participant, 50 short words and 50 long words were randomly drawn (without replacement) from their respective pools. These were compiled into 20 five-word lists, 10 consisting of short words (e.g., pin, veil, slave, tank, dock) and 10 consisting of long words (e.g., monument, infant, planet, camera, auditorium). Five lists of short words and five lists of long words were designated as recall trials, to be used for the backward serial recall task. The remaining lists (a further five each of short and long words) were designated as recognition trials, for use in the recognition task. Thus a different set of 20 trials was prepared for each individual and no word occurred more than once in a given set. Each person's 20 trials were placed in random order for presentation on a computer screen.

A set of five practice trials was also prepared, using words not appearing in the word pools. The practice trials were the same for all participants, and comprised three backward recall trials (two using short words and one using long) and two recognition trials (one using short words and one using long).

For the recognition task, a further 10 short words and 10 long words were randomly drawn (without replacement) from the words remaining in the two pools after compilation of the individual's 20 word lists. These were used as distractors. The 50 words from the person's recognition trials plus their 20 distractors were printed in random order in columns on an A4 sheet, for presentation as a paper-and-pencil task. The same sheet also formed the basis for the remember/know task.

Procedure

After giving informed consent, each participant completed the three tasks in an individual, 15-minute session, in the order below. Participants read printed instructions immediately before each task.

Backward Serial Recall Task Participants sat before a laptop computer with a monochrome screen. When prompted on the screen, they pressed the space bar to begin, and a series of five short words or five long words appeared in black upper-case letters in the centre of the screen, one at a time, at one-second intervals. The participant read each word aloud as it appeared. After each list, a series of question marks or asterisks appeared in the centre of the screen. Question marks were the cue for participants to repeat the five words

back in reverse order to the best of their ability, saying “something” or “pass” for any they could not remember. This was to preserve the serial position of the items recalled. The participant then pressed the space bar to continue to the next trial. If a series of asterisks appeared after the five words, no repetition was required, and the participant simply waited for six seconds until prompted on the screen to press the space bar to begin the next trial. Recall and non-recall trials occurred randomly, and participants did not know until after reading out each word list whether or not they would have to recall it.

Participants completed the five practice trials, followed by their 20 experimental trials (10 requiring backward recall and the remainder no response). For the recall trials, the researcher noted the items and serial positions recalled on a printed sheet showing the word lists for the individual’s trials.

Recognition Task After completing the computer-based task, participants read through their individual printed list of 70 words: 50 from their recognition (i.e., non-recall) trials and 20 distractors. They ticked the words they recognized as having appeared in the lists they had read out during the previous task.

Remember/Know Task Participants read back through the words they had recognized, and indicated, for each one, whether they remembered the word clearly as having appeared in the lists, or whether it just seemed familiar. They wrote the letter R (for remember) beside the words they clearly and consciously remembered having seen in the lists, and the letter K (for know) beside those they just somehow knew or felt had appeared. Responses on the recognition and remember/know tasks were scored after the session.

Results

Backward Serial Recall versus Recognition

Figure 1 shows the mean proportions of words correctly recalled and recognized at each serial position. Serial position refers to the initial presentation order of the words, and not to the reversed order given by the participants. Thus serial position 1 represents the last word in the reversed list, and serial position 5 the first word in the reversed list. These means suggested an advantage for short words over long words in backward recall, and an advantage for long words over short words in recognition. In the analyses that follow an alpha level of .05 was used throughout, but exact p values are also given.

A 2 x 2 x 5 repeated-measures ANOVA for task (backward serial recall vs. recognition) x word length (short vs. long) x serial position (1-5) revealed

significant main effects of task, $F(1, 19) = 5.21, p = .03$, partial $\eta^2 = .22$, and of serial position, $F(4, 76) = 29.74, p < .001$, partial $\eta^2 = .61$, but not of word length, $F(1, 19) = .97, p = .34$, partial $\eta^2 = .05$. This showed that, overall, proportions correct were higher for backward recall than for recognition, that they varied across serial positions, but that overall they did not differ for short and long words. However, there were significant interaction effects between task and serial position, $F(4, 76) = 43.05, p < .001$, partial $\eta^2 = .69$, and between task and word length, $F(1, 19) = 19.73, p < .001$, partial $\eta^2 = .51$. Given the centrality of this last interaction to the first two hypotheses, simple main effects analyses were conducted to examine the influence of word length on backward serial recall and recognition collapsed across serial positions. The results indicated that the proportion of words correctly recalled was significantly higher for short words ($M = .63, SD = .15$) than for long words ($M = .56, SD = .16$), $F(1, 19) = 8.18, p = .01$, partial $\eta^2 = .30$, and that the proportion of words correctly recognized was significantly higher for long words ($M = .56, SD = .18$) than for short words ($M = .44, SD = .17$), $F(1, 19) = 7.77, p = .01$, partial $\eta^2 = .29$. Thus the initial, overall analysis had masked significant opposing word-length effects in the two tasks.

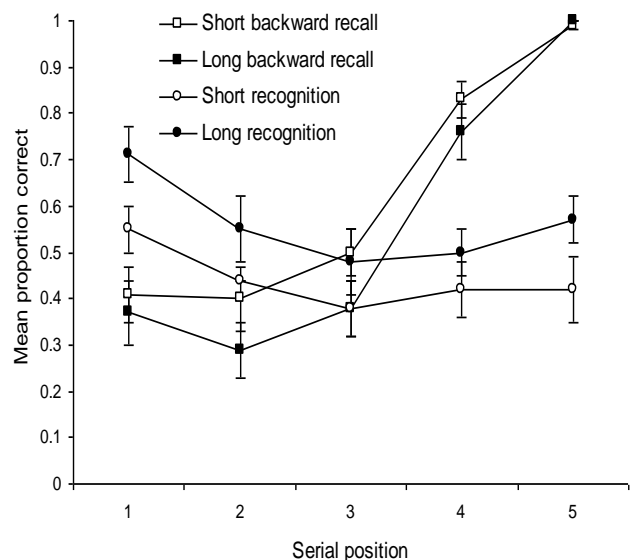


Figure 1: Mean proportions of short and long words correct for each serial position in backward serial recall and recognition tasks ($N = 20$). Error bars show standard errors of means.

‘Remember’ versus ‘Know’

As the proportions of short and long words marked ‘remember’ and ‘know’ would be influenced by the superior overall recognition of long words, the remember/know data were converted to conditional

probabilities for all analyses. That is to say, each person's 'remember' and 'know' scores for a given word length were expressed as proportions of the words of that length recognized, thereby removing the effect of the recognition advantage for long words, and making the comparison between short and long words more stringent.

Figure 2 shows the mean conditional probabilities for 'remember' and 'know' recognition for short and long words at each serial position. A 2 x 2 x 5 repeated-measures ANOVA for recognition type (remember vs. know) x word length (short vs. long) x serial position (1-5) revealed a significant main effect of recognition type, $F(1, 19) = 14.29, p = .001, \text{partial } \eta^2 = .43$, indicating that, overall, mean conditional probabilities for 'remember' recognition were greater than for 'know' recognition. There was no main effect of word length, $F(1, 19) = 2.92, p = .10, \text{partial } \eta^2 = .13$, or of serial position, $F(4, 76) = .70, p = .60, \text{partial } \eta^2 = .04$. There was, however, a significant interaction between word length and recognition type, $F(1, 19) = 26.53, p < .001, \text{partial } \eta^2 = .58$.

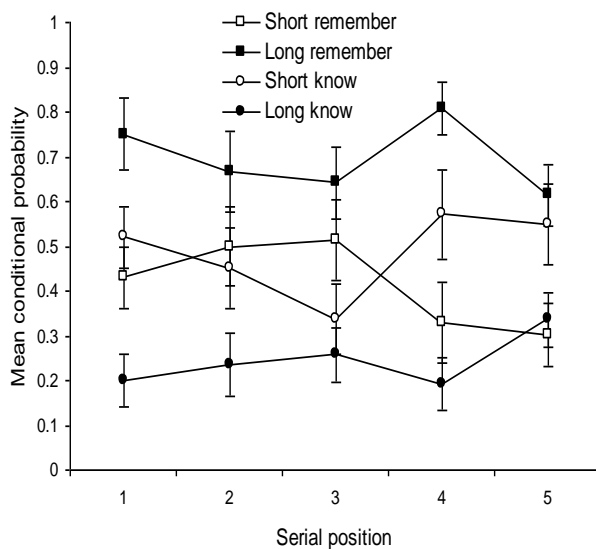


Figure 2: Mean conditional probabilities for 'remember' vs. 'know' recognition for short vs. long words, by serial position ($N = 20$). Error bars show standard errors of means.

Given the importance of this interaction to the second two hypotheses, simple main effects analyses were performed for word length and each of the two levels of the recognition variable. These revealed that for the long words recognized, there were significantly more 'remember' responses ($M = .70, SD = .17$) than 'know' responses ($M = .24, SD = .13$), $F(1, 19) = 54.04, p < .001, \text{partial } \eta^2 = .74$, whereas for the short words

recognized, there was no significant difference in 'remember' ($M = .41, SD = .21$) and 'know' responses ($M = .49, SD = .18$), $F(1, 19) = .79, p = .39, \text{partial } \eta^2 = .04$.

Discussion

The results supported the hypothesis that backward serial recall would be significantly better for short words than for long words. This was consistent with the incidental findings of Cowan et al. (1994) and Walker and Hulme (1999) on backward recall, but not with the results of Tehan and Mills (2007), who found no word-length effect. However, Tehan and Mills used lists of only four words (compared with five in the present study), and words of one versus two or three syllables (compared with one versus two to five syllables here). Thus the emergence of a word-length effect in backward recall may depend on the particular manipulation of length used.

The present results also supported the hypothesis that recognition would be significantly better for long words than for short words. This finding was consistent with previous studies of word length in recognition (e.g., Hendry & Tehan, 2005; Tehan & Tolan, 2007).

Taken together, the results from the backward serial recall and recognition tasks were consistent with the predictions of the item-order hypothesis, with the order-based recall task showing the expected advantage for short words, and the item-based recognition task showing the expected advantage for long words. The observed word-length effects might therefore be seen as reflecting a trade-off between item and order information in the two tasks (Hendry & Tehan, 2005).

In considering other possible explanations for this pattern of results, the points made by Tehan and Tolan (2007) also apply here. An account based on TDR or on item discriminability (see Hulme, Surprenant, Bireta, Stuart, & Neath, 2004) would fit the data for the immediate serial recall task. A TDR model would view the short words as having an advantage for rehearsal in a time-limited store, while a discrimination account would view them as having an advantage in terms of their lesser complexity and (assumed) greater distinctiveness. However, neither of these models would be able to account for the reverse word-length effect observed in the (long-term) recognition task. In TDR the traces would by then be presumed to have decayed. In the discrimination account, an advantage for long words would be predicted only if they had been learned in mixed-length rather than pure lists (Hulme et al., 2004; Hulme et al., 2006). Thus the item-order explanation offered the best fit to the present results.

The results of this study also supported both hypotheses concerning the two categories of recognition. For long words recognized, significantly

more were categorized as 'remember' than as 'know'. For short words recognized, there was no significant difference in the likelihood of 'remember' and 'know' judgments.

If the 'remember' and 'know' responses successfully captured the distinction between conscious recollection and general familiarity, respectively, we can infer that there was a qualitative difference in the type of information encoded for long and short words. The long words appear to have been encoded with more episodic information than the short words, thereby enhancing their retention. The short words did not seem to benefit systematically from this enriched form of processing, and were therefore more easily forgotten over the retention interval.

Thus the remember/know results from this study suggest an explanation for the long-word advantage in the recognition task. They are also consistent with the remember/know patterns described in the literature in relation to low versus high frequency words (Gardiner & Java, 1990), and generated versus intact words (Gardiner & Richardson-Klavehn, 2000). Furthermore, these results provide preliminary evidence for the differential processing of long and short words that has to date only been an assumption in the item-order approach.

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