Table 3
Number of Ss Making the Three Possible Loudness Judgments
in Each of the Three Experimental Conditions

Group	Noise Level	Speech Level	Number of Ss Saying Noise Louder	Number of Ss Saying Speech Louder	Number of Ss Saying the Same Intensity
1	80 dB	90 dB	0	12	0
2	90 dB	90 dB	0	11	1
3	115 dB	90 dB	2	8	2

However, all three categories occur in Group 3. If a two-way classification is made in terms of speech and nonspeech responses, then eight speech responses must be compared with four nonspeech responses. The probability of four nonspeech responses being given on a chance basis is 0.194. If, on the other hand, a two-way classification is made in terms of white noise and nonwhite noise responses, which seems reasonable since it would be surprising if only two Ss had judged 115-dB white noise to be louder than 90-dB speech, the probability of obtaining 2/12 white noise responses is 0.019. It is worth adding that, while shadowing, all Ss in Group 3 were shouting the words as they heard them.

Thus, a significant proportion of Ss judged 90-dB shadowed speech as louder than 90-dB white noise and a surprisingly high proportion, significantly so if the above argument is accepted, judged 90-dB shadowed speech to be louder than 115-dB white noise. It should be noted, however, that while the judgments of relative loudness appeared easy to make for Ss in Groups 1 and 2, they were much more difficult to make for Ss in Group 3. If we had taken confidence ratings, we would

have more precise evidence to offer in this connection.

In conclusion, it seems that the findings of this study lend some support to Treisman's filter-amplitude theory and run counter to Neisser's suggestion referred to above. It appears likely that the act of switching attention to one ear does result in some attenuation of material presented to the other, even when this material is presented at a considerably higher intensity. It would be of interest to see if the same findings are obtained when speech of different intensities is presented to the two ears in a dichotic listening situation.

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NOTE

1. We should like to thank Dr. J. T. Reason for his helpful comments on an earlier draft of this paper.

Semantic and acoustic similarity and their effects on short-term retention

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Ss were given five-word sequences which they were asked to recall after three intervals of interpolated activity (5 sec, 20 sec, and 40 sec). The sequences were of three types: acoustically similar, semantically similar, or control. There was a significant interaction between retention interval and type of similarity in which

only the acoustic effect was significant at 5 sec and only the semantic effect at 40 sec. These findings seem to resolve some previous discrepancies and are viewed as being consistent with Waugh & Norman's (1965) distinction between PM and SM. It is suggested that PM is primarily acoustic, while SM is primarily semantic.

Several investigators have argued that at least two independent memory traces are

involved in the retention of verbal information. Waugh & Norman (1965) have used the terms primary memory (PM) and secondary memory (SM) in referring to these mnemonic processes. PM is viewed as a system of very limited capacity that receives and maintains information by rehearsal for several seconds until it can be transferred to SM, a system of much larger capacity where the information can be maintained indefinitely.

Support for such a distinction has come from studies that have shown different stimulus properties to be important in short-term and long-term retention, suggesting that PM and SM involve different modes of storage. There is a good deal of evidence that indicates that short-term retention is significantly influenced by the acoustic and/or articulatory (A)¹ similarity between the items to be recalled (Conrad, 1964; Wickelgren, 1965; Baddeley, 1966), but that long-term retention is influenced by the semantic (S) similarity between the items (Underwood & Goad, 1951; Baddeley & Dale, 1966).

Recently, several studies have shown short-term retention to be influenced by semantic factors as well (Wickens & Eckler, 1968; Wickens & Simpson, 1968; Conrad, Freeman, & Hull, 1965). These findings would seem to question the use of A and S effects as a basis for distinguishing between PM and SM. However, Waugh and Norman's model would seem to be able to account for these seemingly discrepant findings. Their model assumes that PM and SM are not mutually exclusive systems, but, rather, that they overlap in time. Therefore, the probability that an item is in PM is highest immediately after presentation and declines over the retention interval, while the probability that the item is in SM is lowest immediately after presentation and increases over the same interval. Both PM and SM would therefore be expected to affect retention, even over short intervals. Those studies showing S effects in a STM task have used relatively long retention intervals (25 sec), while those showing an A effect have used short intervals (6 sec). Waugh and Norman have argued that most of the data from STM studies actually reflect the properties of both systems.

The purpose of the present experiment is to test for an interaction between type of similarity and the length of the retention interval. If the storage mode is A in PM and S in SM and if the assumptions of Waugh and Norman are correct, A similarity should have its greatest effect after a short retention interval, while S similarity should have its greatest effect after a long interval.

SUBJECTS

Ss for the experiment were 66 undergraduate volunteers from Whitworth College.

DESIGN

A 3 by 3 nested design was used with three types of similarity—semantic (S), acoustic (A), and control (C)—and three retention intervals—5, 20, and 40 sec. Type of similarity was a between-S variable, while interval was within-S.

STIMULI

Stimuli were three lists of five-word sequences. There were 18 sequences in each list. The sequences for each list were generated from a separate set of eight words (all three sets were taken from Baddeley, 1966). The C words were: old, deep, foul, late, safe, hot, strong, thin. The A words were: mad, man, mat, map, cad, can, cat, cap. The words in the S set were: big, long, broad, great, high, tall, large, wide. Within each list, words were selected randomly to make up the sequences, with the following constraints: (1) no word occurred more than once in a sequence, (2) each word was used an equal number of times in the list, and (3) each word appeared in each serial position an equal number of times. The entire experimental session was recorded on tape.

PROCEDURE

A modified Peterson & Peterson (1959) procedure was used. A typical trial proceeded as follows: (1) presentation of a five-word sequence (one word/1 sec); (2) interpolated task, lasting 5, 20, or 40 sec; (3) written ordered recall, lasting 15 sec. S was required to monitor each word out loud, as it was presented, to control for perceptual errors (i.e., failure to hear the word). The word "stop" signaled the end of the sequence. S immediately looked down at a sheet of paper containing a three-digit number and began counting backwards from it, out loud. S was instructed to write the number on the paper as he counted and to work as rapidly as possible. The word "recall" signaled the end of the interpolated task and S immediately turned the sheet over and attempted to write the five words in the order presented. There was a 3-sec interval between trials. This procedure was

repeated for all 18 sequences. Each S received words from only one of the three lists but was tested over all three retention intervals an equal number of times. The order of presentation of the intervals was random.

RESULTS

Words appearing in their proper serial position in the sequence were considered correct. All other responses were classed as errors. Sequences containing a perceptual error were not included in the data and Ss who had nine or more perceptual-error sequences were eliminated from the analysis. Nine Ss were eliminated on this basis. Table 1 shows the mean number of errors per sequence and the standard error of the mean for each treatment condition. A mixed-design ANOVA (Myers, 1966) showed the main effect of type of similarity to be significant [$F(2,59) = 16.57$, $p < .001$] and main effect of retention interval not to be significant [$F(2,108) = 1.32$]. The interaction of Type by Interval was significant [$F(4,108) = 24.10$, $p < .001$].

In order to analyze the interaction further, pairwise comparisons were made between selected treatment means, using Tukey's method (Guenther, 1964). Table 2 shows the results of five pairwise comparisons. Each comparison was tested at the .01 level so that the overall $\alpha = .05$. It can be seen that only the A effect is significant at the 5-sec interval and that only the S effect is significant at 40 sec. The S effect is not significant at 20 sec.

DISCUSSION

The prediction made at the beginning of this paper is confirmed by the finding that only the A effect is significant at 5 sec and only the S effect is significant at 40 sec. These results seem to account for the discrepant findings reported by the Wickens group. It is suggested that the term "short-term memory" has come to refer more to an experimental task, typically involving a limited number of items, an interpolated task, and a relatively short retention interval (less than 1 min), than to a particular storage system. Waugh and Norman's model seems to be a fruitful way of viewing the distinction between a short-term and a long-term storage system. The results of the present experiment

suggest that if recall at 5 sec is primarily from PM and if recall at 40 sec is primarily from SM, then PM utilizes an acoustic and/or articulatory code, while SM makes use of a semantic (associative) code. It would seem, however, that the particular effect observed in this experiment is probably more a function of the particular task used than any compulsory features of the memory systems involved. In other words, it is likely that A effects could be obtained at intervals longer than 5 sec and that S effects could be obtained at intervals shorter than 40 sec merely by varying the nature of the task. For example, it is likely that the probability of recall from PM will decrease more rapidly (leading to a more rapid decline in A effects) in tasks where supraspan lists are used or where the difficulty of the interpolated task is high (e.g., classification as opposed to counting).

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NOTE

1. No attempt is made to distinguish between acoustic and articulatory factors in this experiment and one or both are assumed to be operating to produce any A effects. Wickelgren (1969) has argued that attempts to separate the two have been inadequate.

Table 1
Mean Errors Per Sequence and Standard Error (SE) of the Mean for Each Treatment Condition

Mean and SE	Interval (Seconds)		
	5	20	40
Control	1.42	1.65	1.83
SE	.18	.17	.21
Acoustic	3.31	3.14	2.16
SE	.16	.12	.12
Semantic	1.63	2.03	2.72
SE	.21	.21	.23

Table 2
Pair-Wise Comparisons Between Means Using Tukey's Method Where $T = 0.56$ for $\alpha = .01$

Interval	Comparison	Difference	P Value
5 Sec	C vs A	1.89	<.01
	C vs S	0.21	n.s.
20 Sec	C vs S	0.38	n.s.
40 Sec	C vs A	0.33	n.s.
	C vs S	0.89	<.01