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THE RETENTION OF IGNORED INFORMATION

A Dissertation

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

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A unifying theme running through many contemporary approaches to human memory is their concern with identifying the aspects of the information contained in a stimulus which forms the basis for its retention. The distinction between acoustic and semantic coding has been of particular interest. In its most often encountered form this distinction has been offered as one of the justifications for proposing separate short-term and long-term storage systems. Thus, it is argued that the representation of a verbal item in short term memory is based primarily on its acoustic features, while the item's meaning is the more important determinant of its retention in long term memory.

Recent demonstrations of semantic encoding in short term memory (Bregman, 1968; Shulman, 1970) have called the validity of this argument into question. On the basis of experimental evidence Shulman (1971) has proposed that the apparent discrepancy between the common finding that acoustic factors account for much of the variation in short term memory performance and these demonstrations of semantic encoding in similar paradigms can be resolved by considering encoding as a time dependent process. He argues that features of an item most closely related to its sensory input, such as its phonemic characteristics, are encoded more rapidly than its semantic features. In order to maximize the time available for rehearsal in a short term memory task, subjects (Ss) may limit themselves to this more rapid acoustic
encoding unless the task explicitly requires encoding of semantic information. Similarly, Eagle and Ortoff (1967) have shown that the requirement to perform a secondary task (digit classification) during presentation of the to-be-remembered items increases the relative importance of the acoustic features of those items. The present experiment uses a task frequently employed to manipulate the allocation of attention and examines the effect of these manipulations on the encoding and retention of verbal material.

**Shadowing and the retention of "ignored" messages**

The dichotic shadowing paradigm, introduced by Cherry (1953), requires a listener to repeat a message presented to one ear as he hears it, while a second message is simultaneously presented to the other ear. Early studies used continuous prose passages as the shadowed and non-shadowed messages, while more recent experiments have used discrete series of unrelated items presented at a high (3/second) rate. In either case, the attractiveness of the method in studying selective attention stems from its assurance that Ss are attending to the shadowed channel: lapses of attention are immediately apparent as increases in shadowing errors (Mowbray, 1964). However, while it is thus clear that Ss do process the attended message to the point of being able to repeat it, the fate of the "unattended" message is less certain. Yet it is precisely this issue - the extent to which rejected messages are processed prior to selection - which has formed the basis for the continuing controversy between "early" (e.g., Broadbent, 1958; Treisman, 1969) and "late" (e.g., Deutsch and Deutsch, 1965; Norman, 1969a) theories
of the selective process.

Two of the original experiments using the shadowing paradigm (Cherry, 1953; Moray, 1959) indicated that Ss could report "crude physical characteristics" of the non-attented message (e.g., the sex of the speaker) but gave no indication of recalling the content of the message presented on that channel. This observation provided the impetus for the 'early' selection models, which maintain that the choice of which message to exclude or attenuate is based on analysis of the physical characteristics of each message.

But Norman (1969a) has recently shown that Ss can identify items from the non-shadowed message when the delay between presentation and test is minimized. He interprets this as consistent with the "late" selection models, which maintain that selection can take place only after the meaningful components of all incoming signals have been extracted. But in addition to reducing the retention interval Norman (1969a) altered Moray's (1959) procedure in a second, and it will be argued, critical detail: Moray's Ss did not expect to be tested on their retention of the non-shadowed material, while Norman's Ss were extensively trained in remembering it.

The present paper proceeds from the simple thesis that on logical grounds alone Ss cannot "try to ignore" a message that they are "attempting to remember." Thus a demonstration that Ss can divide their attention between a shadowed and a non-shadowed message, to the extent of being able to recognize the non-shadowed input immediately after its presentation, does not speak to the
issue of the extent to which that message must be processed when Ss are in fact trying to ignore it. More specifically it is proposed that the strategy which S is encouraged to use in distributing his attention over the two inputs results in important differences in the encoding of each message.

**Selective attention: Shadowing with attention focused on the shadowed message**

The defining characteristic of each of the following studies is their inclusion of some technique designed to discourage Ss from attending to the non-shadowed message. Hence any evidence of processing of that message may be taken as an indication of the limits of Ss ability to ignore irrelevant auditory input.

Cherry (1953) provides verbal descriptions of the results of several studies in which Ss shadowed a passage of continuous prose presented to the left ear, while various distracting messages which S was instructed to ignore were presented to the right ear. Across studies the non-shadowed messages used included (1) English prose, spoken in the same male voice (2) English prose, in a high-pitched female voice (3) a German passage, in the same male voice (4) reversed male speech and (5) a 400 Hz tone. At the conclusion of the shadowing trial, Ss were asked what they could report about the non-shadowed message. Crucial to the interpretation of Cherry's results is the fact that at the time of presentation Ss did not know that they would be questioned on the non-shadowed message. As Cherry noted, since it is unreasonable to expect Ss not to try to attend to that message once they know they will be tested on it, "it is considered unfair to try this particular test more than
once with the same listener" (1953, p. 978).

Two observations of some interest were made. The first, with regard to the shadowed message, is that while S finds errorless shadowing surprisingly easy after a modest amount of practice he may have very little idea of what the message he has repeated is all about. Thus, although the occurrence of shadowing leaves no doubt that the attended message was accurately perceived, there is little to indicate that its semantic features are stored. The second point, which applies to the non-shadowed message, is that while Ss could distinguish speech from a tone and could identify the sex of the speaker, they were unable to recall any word or phrase from the rejected ear nor able to make definite identification of the language as English.

An experiment by Moray (1959) - which like Cherry's used the one observation questioning technique - gave dramatic emphasis to the apparent lack of retention of non-attended material after a short interval. Ss shadowed a prose message presented to one ear, while a list of seven unrelated words was repeated 35 times to the other ear. After a delay of approximately 30 seconds Ss were given a recognition test consisting of items from the shadowed message, items from the non-shadowed list, and unpresented items. While details of the experiments were not presented, Moray (1969) later indicated that Ss were instructed to say whether the test items had occurred in either message. 4.9 out of 7 words from the shadowed message were correctly recognized. This, together with Cherry's (1953) report of little comprehension of the shadowed message, suggests the storage of phonemic information
from that message. No evidence of retention of the non-attended items - though repeated 35 times - was found. In fact, the number of words recognized from the rejected message was noticeably less than the number of false recognitions of unpresented words (1.9 vs 2.6 of 7).

This latter result, that recognitions of items from the unattended message were less frequent than false recognitions, may be of some consequence in interpreting the demand characteristics of the post hoc questioning technique. Notice that under instructions to ignore the non-shadowed message, recognizing an item from that message may be taken by S as an admission of his having failed to follow instructions. Thus a low recognition rate for non-shadowed items may indicate either a true lack of retention or a strategy of not admitting to recognize items that are recalled as coming from the non-shadowed channel. In the former case (no retention) the recognition rate for non-shadowed items should be at chance level, i.e., equal to the recognition rate for unpresented items. Only in the latter case (suppression of recognition responses for items from the non-shadowed channel) would the rate of recognition be expected to fall below chance level.

In contrast to these two post hoc questioning studies which show little retention of non-shadowed messages in the focused attention situation, two others which relied on spontaneous comments by S indicate retention of phonetic, and possibly semantic, information from both messages. Again Cherry (1953) first used this technique, in which identical messages are played to both
ears, separated by a variable time lag. Here, as in the questioning method, Ss are instructed to shadow the designated message and told that the second message was to be ignored. Across trials, the phase lag between messages is gradually reduced until Ss first comment that they have noticed that the two messages are the same, at which point their service is terminated. Recognition of the identity of the two inputs at non-zero lag is taken as evidence that the leading message has been stored for an interval equal to the critical phase delay.

In Cherry's experiment nearly all Ss noticed the identity at delays ranging from 2 to 6 seconds. Unfortunately, Cherry does not report which of the two messages was leading the other. Treisman (1964) noted that this detail was critical, for if the non-shadowed message led, storage of irrelevant information would be indicated. Treisman also raised the question of the level of processing of the stored material and sought to determine whether the two inputs were compared on the basis of their acoustic characteristics or their meaning. An experiment was performed in which the mean delay interval at which the identity was noticed was compared when the shadowed message led or lagged behind the other. For different groups the two recordings of the message were (1) spoken in the same voice (2) spoken in different voices (3) spoken in the same voice but in different languages (bilingual Ss). It was found that when the shadowed message led, identity was noticed at a mean delay of 4.5 seconds, while a significantly shorter mean delay (1.4 seconds) was required when the non-
shadowed message was leading. This was taken as evidence that the trace of the shadowed message decays at a slower rate. No effect of voice differences was found in either lead or lag conditions, which suggested that the comparison was not made on the basis of unanalyzed physical properties. Further support for this conclusion, at least when storage of the shadowed message was required, stems from the fact that the identity of the shadowed message and its translation was noticed at a mean delay of 3.5 seconds when the shadowed message led. But when the non-shadowed message led, only 1 of 8 Ss noticed identity at even the shortest delay used (1.5 seconds). As Treisman herself noted, however, the validity of the lead/lag comparisons in these bilingual conditions is somewhat lessened by the fact that the French translations could not follow the exact word sequence of the English message; thus, for example, phrase reversals could have resulted in portions of the non-shadowed message leading in what was ostensibly a lag condition.

These results do indicate that some analysis is involved in the encoding of both the attended and ignored material, in that voice differences do not disrupt the detection of identity regardless of which message must be stored. Semantic encoding, however, as reflected in the detection of the identity of a message and its translation, is indicated only when the shadowed message is retained. In a second experiment Treisman replicated the same-voice condition of Exp. 1, but added groups in which unrelated words were used in place of continuous prose. It was argued that changing the verbal structure of the message (reducing the semantic unit from a phrase to a word) could have an effect only where semantic analysis
preceded storage of the leading message. As expected, when the
shadowed message led, the mean delay at which identity was noticed
was less for the random words (2.9 vs. 4.9 seconds). But when the
non-shadowed message led, so that the identity of the two messages
could be noticed only on the basis of its representation, no effect
of verbal structure was found.

A recent experiment (Lewis, 1970) challenges the conclusion
that excluded messages are not analyzed for meaning, but does not
speak to the issue of storage of semantic information. In Lewis's
experiment Ss shadowed lists of 11 unrelated words presented to one
ear, while a second list of 11 different words, synchronized with
the first, was presented to the other ear which Ss were instructed
to ignore. The non-shadowed words were chosen so as to be related
to the shadowed word in the same serial position as (1) a high
associative strength non-synonym (2) a low associative strength
synonym or (3) low associative strength, non-synonym control. For
each type of non-shadowed material the mean shadowing latency for
the corresponding shadowed word was obtained. In each of two
experiments shadowing latencies were significantly increased when
synonyms were presented to the non-shadowed ear. Latencies when
high associates were presented on the distractor channel were
actually shorter than controls, but subsequent analyses indicated
that this was due to semantic differences between the high and low
associate word pools. In no case did conventional measures of
shadowing accuracy (% words correctly shadowed) show an effect of
the content of the non-shadowed message. As a rough check on the
possibility that Ss differentially switched attention to the non-shadowed message as a function of its content, a control group shadowed the same tapes with instructions to try to remember the content of the non-shadowed message while maintaining shadowing accuracy (divided attention instructions). In no case were Ss able to recall items from the non-shadowed channel.

In summary, shadowing studies using focused attention instructions indicate (1) acoustic and semantic features of the shadowed message are encoded and retained over short intervals (2) acoustic features of non-shadowed messages are also retained (3) semantic features of non-shadowed messages are processed, but (4) do not remain available for subsequent recall. A rather different pattern of results is obtained in the same paradigm, however, when Ss are not permitted to ignore the non-shadowed message.

Divided attention: shadowing one message while trying to retain another

The preceding studies were concerned with the extent to which S can successfully ignore information from the rejected channel. Divided attention studies, on the other hand, explicitly instruct Ss to retain information from the non-shadowed channel, and seek to determine their ability to do so.

Not surprisingly, Ss show superior recall of non-shadowed material when they are instructed to try to retain it. In most cases, however, this is achieved at a cost of a manifest loss in shadowing accuracy. Less often, and particularly with highly practiced Ss, retention of the non-shadowed material has been demonstrated without an accompanying loss in the proportion of
words correctly shadowed. While this has occasionally been interpreted as a challenge to the view of man as a single channel information processor, Lewis's (1970) demonstration that shadowing latencies show interference effects where % correct shadowing does not suggests that the latter dependent variable may simply lack the sensitivity to show decrements imposed by the performance of a concurrent memory task.

Mowbray (1964) required Ss to shadow a monaural list of 50 unrelated words. The contralateral channel was quiet, except for the presentation of from 1 to 3 "target words" at randomly chosen positions. Ss were informed that these words would be presented and were instructed to attempt to remember them when they occurred. A free recall test was given immediately after completion of the shadowing trial. On control trials Ss received no words on the second channel. Across conditions approximately 50% of the target words were correctly recalled. A rough measure of serial position effects, obtained by dividing the shadowing list into thirds, indicated a marked recency effect: only 46% of the words presented during the first third of the trial were correctly recalled, whereas 75% of those from the final third were remembered. Examination of the shadowing data indicated that at all serial positions presentation of a target word resulted in a switching of attention away from the shadowing channel. Shadowing errors occurred on over 90% of the words which were simultaneous with target words.

This high rate of shadowing errors may be attributable to Mowbray's presentation of the target words on an otherwise silent
channel. Treisman (1964) notes that the sudden onset of speech often leads to an "involuntary switching of attention." Peterson and Kroner (1964) report an experiment similar to Mowbray's, in which the target items were letters presented in a continuous list of non-shadowed digits. A second list of digits, recorded in a different voice, were presented to the opposite ear for shadowing.

In scoring their data the Es adopted a strict criterion of accepting only those trials on which no shadowing errors were made. Approximately 60% of the experimental trials were eliminated on this basis. Unfortunately no analysis of the relation between the position of the target word and the location of the shadowing error was reported. Recall following the remaining error free trials ranged from 53% correct when the target item appeared in the final serial position to 32% when 12 items separated presentation and test. The authors argued that the recall errors when the target item was presented in the final serial position could be attributed to failures to detect it. If this logic is accepted, then the proportion of items correctly detected which were subsequently available for recall would be approximately double the simple proportion correct (47% of the items were misperceived). Across serial positions the proportion correct recall without disruption of shadowing would then exceed the proportion correctly recalled in Mowbray's experiment where shadowing was invariably interrupted!

Norman (1969) noted that the Moray (1959) study which showed no retention of non-shadowed items had used a relatively long
retention interval. Waugh and Norman (1965) had argued that conscious attention was necessary for the transfer of material from short to long-term memory. Thus, an experiment was designed to compare immediate and delayed retention of non-shadowed material. Ss shadowed a continuous stream of unrelated words, presented to one ear, while a list of 6 two digit numbers was presented to the other. Ss were instructed to attempt to remember these digits, while maintaining their shadowing accuracy. On each trial a single recognition test followed the last digit either immediately or after a 20 second delay. In the latter condition, Ss continued to shadow during the retention interval. Two highly practiced (40 hours) Ss were tested. Single task control conditions were also run for both the shadowing and the retention tasks.

In the immediate memory test, correct recognitions, though inferior to the memory only control, were significantly greater than chance for all but the first number presented. Similar recency effects were obtained in the dual task and single task conditions. In the delayed test, however, recognition was at the chance level in all serial positions. Norman concluded that even while Ss are kept busy shadowing, other material is entered into short term memory; it is primarily transfer to long term storage that is disrupted by attending to the shadowing task as well as the memory task.

Several details of Norman's experiment, and his contrast of its results to those of Moray (1959) warrant further comment.

First, as already noted, the situations in which Moray found no
retention and Norman did differ not simply in retention interval, but also in the demand characteristics of their experimental procedures. Recall that Moray used naive Ss, tested once, who were unaware that the retention of the non-shadowed material would be tested. Norman, by contrast, gave Ss considerable practice at recalling non-shadowed material before data collection began. This difference becomes significant once the assumption that accurate shadowing fully captures Ss attention is questioned. Interestingly, Norman himself develops much of the current argument in discussing Cherry's (1953) caution against multiple observations with the same S:

"...why should it be unfair to use a listener in the same test several times? Is it unfair because after a while S would be able to say what language had been presented (in the non-shadowed channel)? If so, just what is taking place when a subject shadows; can he selectively accept or reject other material?" (1969b, p. 21)

Norman's own (1969a) data indicate an affirmative answer to the final question. The conclusion that Norman failed to draw, however, is that retention of non-shadowed material thus need not tell us anything about the level to which the analysis of non-attended material is taken. Clearly the poorer recognition in Norman's (1969a) dual task condition relative to the memory only control indicates that concurrent shadowing reduces the processing capacity available for other inputs. This, then, is the limited capacity which is the reason for proposing a selector mechanism. But to gain information about the level at which selection takes place, one must structure the situation such that there is reason for selection to occur.
A related issue is the type of memory system involved in Norman's experiment, since all theories of selective attention do, in fact, provide some mechanism for the storage of unattended material. Norman (1969a) notes that proponents of early selection might accommodate his results by appeal to a pre-analytic sensory buffer (e.g., Broadbent's S-system). Norman rejects this interpretation and opts instead for recall from a verbally encoded short term memory, citing the quantitative similarity between the serial position curves he obtained and those found in other short term memory experiments (viz., Norman, 1966; Wickelgren and Norman, 1966). However, it is not at all clear that the positively accelerated recency functions observed are any less similar to those ascribed in other experiments to "pre-categorical acoustic storage" (e.g., Crowder and Morton, 1969). And again, even if Norman's argument is accepted, one may object that verbal encoding of partially attended material implies nothing about the encoding of rejected inputs.

A final experiment (Glucksberg and Cowan, 1970) indicates, again indirectly, that even under conditions requiring the sharing of attention categorical information from a non-shadowed message may not be stored. In that experiment, Ss shadowed a continuous prose passage presented to one ear while a second passage was played to the other. Single digits were occasionally inserted in the non-shadowed message, and Ss were instructed to write down any digit they heard. Only 5.7% of the non-shadowed targets were thus spontaneously detected (c.f. Treisman & Geffen, 1967). In addition,
a visual cue followed some of the undetected targets by 0 to 20 seconds. Ss were told that when this probe light came on they were to "think back and try to remember if any digit had occurred recently which they might have missed." If S thought a digit had occurred, he was to make a checkmark; if he remembered what the digit was, he was to write it down.

Under these conditions 26% of the target digits were correctly recalled after a .3 second delay; the detection rate declined rapidly with delay, reaching an asymptote of 5% at 5.3 seconds. Thus within the first five seconds Ss showed substantial memory for items that they did not report detecting at the time of their occurrence. Three observations led the Bs to infer that an echoic or pre-categorical memory system was involved. First, the spontaneous detection rate for prose homophones of the targets ("TO", "TOO", "FOR") was identical to the correct detection rate, indicating that Ss were not following the context of the non-shadowed message. Secondly, no S ever reported the occurrence of a digit that he could not identify; "digitiness" as a category did not seem to be stored. Finally, when querrated as to how long before the probe the digit had occurred, Ss uniformly responded "Immediately", regardless of the actual delay used. Thus the memory for the recalled digits did not include "time tags."

These studies of the retention of non-shadowed material under divided attention instructions show, as expected, that Ss do retain more of that material when they have reason to. Even here, however, that memory seems limited to storage of a short term
nature: whatever effect concurrent shadowing may have upon the encoding of non-shadowed material, it does seem to effectively prevent its transfer to long-term memory.

But what of the encoding of that information? Here, as was the case with studies using focused attention instructions, little direct evidence is available. In fact, whereas at least one focused attention study (Treisman, 1964) has attempted to bring the question under experimental control, conclusions about the dimensions of encoding of non-shadowed material under divided attention instructions rest almost exclusively on incidental observations.

Moreover, despite their concern with the accuracy of shadowing performance, none of these divided attention studies has examined the retention of the shadowed material. Both Moray (1959) and Treisman (1964) found good retention of material on the focal shadowed channel, although in neither case were subjects encouraged to remember anything! Should one expect memory for the shadowed material to be impaired when attention is partially shifted to retaining input from the other channel? Or does the act of shadowing itself lay down a trace sufficient to sustain immediate recall? Can one really forget what he has just been saying, as distracted lecturers are sometimes heard to claim?

The purpose of the reported research is to test the hypothesis that instructional manipulations of attentional strategies will produce both quantitative and qualitative changes in the immediate retention of shadowed and non-shadowed inputs. In an attempt to
separate the effects of shadowing a message from those of trying to retain it, Ss were required to shadow one of two simultaneous dichotic inputs under instructions to attempt to remember (1) the shadowed message or (2) the non-shadowed message. To gain information about the nature of the encoding process used, Ss will be tested using a variant of the probe technique used by Shulman (1970), which requires S to indicate whether a test item is (1) identical to, (2) a rhyme of, or (3) a synonym for an item presented on the to-be-remembered channel. Evidence of the level of analysis to which distracting material is subjected will be obtained by comparing false recognitions of distractor items to false recognitions of test items not previously presented on either channel. By instructing S to indicate whether a test item occurred on the to-be-remembered channel false recognitions of distractor items would indicate the level of encoding which occurs despite efforts not to remember that material. Finally, the influence of shadowing and of encoding strategies on the rate of forgetting will be determined by examining recognition probabilities as a function of input serial position.
METHOD

The method chosen was designed to gain information about the encoding of material from both to-be-remembered and distractor channels. Ss were presented with two simultaneous 10 item lists, one to each ear, and were instructed to shadow one while also trying to remember either that list or the other list. Following each shadowing trial Ss were given a single recognition test, with instructions to indicate whether the probed item had occurred on the to-be-remembered channel. On any trial the probed item might in fact have occurred on the to-be-remembered channel (in which case "Yes" was the correct answer), on the distractor channel ("No"), or not have been presented ("No"). In addition, independent of the source of the item probed, tests might be any of three types (1) Identity - "_______ was a memory word" (2) Acoustic - "_______ sounds like a memory word", or (3) Semantic - "_______ means the same as a memory word." To encourage Ss to encode each item as fully as possible, probe types were randomly distributed across trials; Ss were unaware of the type of probe to be used prior to its actual presentation. Finally, to permit a possible signal detection analysis of the results, and to protect against ceiling effects in cases where very high recognition accuracy might be obtained, in addition to making "YES/NO" judgments Ss were required to rate their confidence in those judgments on a six point scale.
Design

Factorial combination of three types of probe, three sources of probed items, and two designations of the channel to be remembered resulted in 18 basic conditions. Probe types were Identity, Acoustic, and Semantic, as described above. Probe sources were memory list, distractor list, and unpresented items (catch trials). All Ss served under all levels of these two variables. Between groups of Ss either the shadowed or the non-shadowed channel was designated as the channel to be remembered. Thus, for half the Ss (focused attention) instructions indicated that the same channel was to be shadowed and retained, while the remaining Ss (divided attention) were to shadow one channel while attempting to remember items on the other. In each case Ss were to indicate whether the probed item had been presented on the to-be-remembered channel.

After being trained in both the dichotic shadowing and recognition aspects of the basic task, Ss were given 90 experimental trials. Each trial consisted of a warning signal (the spoken word "READY") on both channels followed one second later by synchronized word pairs, one member of each pair to either ear, presented at a 2/second rate. The channel to be shadowed and the channel to be retained were specified at the beginning of the session, and for a given S did not change throughout the experiment. Immediately after repeating the last word, S turned over a card from the top of a deck placed before him. Printed on the face of the card was a question indicating the type of probe and the probe item, (e.g., "Sounds like CAT"). Ss were given 8 seconds to check their response and confidence rating, and to set the card aside. At the end of this interval,
the warning signal indicated the beginning of a new trial.

Two buffer items which were completely redundant (letters "A", "B" to one ear, digits "1", "2" to the other) preceded every 10 item list, and were included simply to offset any irregularities in performance associated with the initiation of shadowing. Lists of 10 unrelated words followed. Across the experimental session each serial position in both channels was probed once per S under each type of probe. The remaining 30 trials were catch trials, consisting of ten probes of un presented words under each probe type. Thus on 30 trials (when to-be-remembered words were probed) the correct answer was "YES", while on 60 trials (30 probes of distractors and 30 catch trials) the correct response was "NO."

The observation sequence for type of probe, channel probed and serial position were randomized, with the restriction that runs of probe type not exceed three and channel probed not exceed five.

Ss were 80 undergraduate volunteers (40 per group) who served in a single session lasting approximately one hour.

**Materials & Apparatus**

The 90 experimental trials required 180 lists, consisting of a total of 1740 un tested filler words, 20 single items for identity probes, 20 synonym pairs, 20 rhyme pairs, and 30 un presented catch trial probes. With the exception of the rhyme pairs, all items were chosen from the word pool used by Shulman (1970). The synonyms in that set had been chosen "to be of maximum similarity, with preference given responses showing unimodal, peaked frequency distributions in the Riegel (1965) or Jenkins & Palermo (1965)
norms. The remaining words were one or two syllable words three to six letters in length occurring at least once per million in the Thorndike-Lorge count. The 20 rhyme pairs (Shulman's homonyms are inappropriate for auditory presentation) were drawn from a list prepared by Frederiksen and Aaronson (undated mimeo). The probe items chosen from these two sources were matched as closely as possible in both length and frequency.

For each probe type, the 20 pairs were divided into 2 sets of 10 which were assigned to either the to-be-remembered or the distractor channel. For half the Ss in each group this assignment was reversed. Within each channel each pair was tested in each of the 10 serial positions with equal frequency across Ss. Thus the assignment of words to channels and to serial position was counter-balanced over groups of 20 Ss.

Lists were recorded in a monotone voice by a male speaker on a two channel stereo recorder. While recording the speaker monitored metronome clicks played on a second recorder at a 2/second rate as an aid to pacing and synchronization. Lewis (1970) determined that a mean error of synchronization of no more than 25 msec. can be achieved in this way. Counterbalancing of channel shadowed and channel to be remembered insured that there was no systematic relation between variations in synchronization, intensity, etc. and experimental conditions. Lists were presented over a low impedance stereo headset. Ss shadowing protocols were recorded on a second machine.
Procedure

Prior to the first experimental trial, Ss were practiced on both the recognition and the shadowing tasks. At the beginning of the session, the recognition task was explained and Ss were given 18 practice trials including 5 probes of each type and 5 catch trials. For these practice trials 10 word lists were presented to both ears at a 2/second rate.

Ss were next practiced on the shadowing task. After five trials shadowing single lists presented to one ear, Ss were introduced to the dichotic condition and continued shadowing until a criterion of two successive error free shadowing trials was reached. Twenty pairs of 10 word lists were available for practice. If additional practice was required these same lists were repeated. During practice S was told his task was to listen to the words on the designated channel and repeat them as soon as he heard them. The words used in both recognition and shadowing practice were chosen from the filler words in Shulman's (1970) pool not used in the experimental lists.

At the completion of practice Ss were given further instructions describing the combined task trials. In the focused attention condition Ss were told to attempt to remember the words they were going to shadow and that a recognition test would follow each trial. They were also informed that items from the non-shadowed channel and new items would also appear as probes, but that since E was interested in their ability to remember the shadowed items the correct answer to either of these probes was
"NO." In the divided attention condition Ss were told to attempt to remember the non-shadowed items; since S was interested for their memory for those items, they should respond "NO" to items from the shadowed channel as well as to new items.
RESULTS

The data of primary interest are the proportion of "YES" recognition responses for each cell of the experimental design. For each of the six Attentional Instruction X Probe Type conditions, three such scores may be computed: the probability of correctly recognizing a to-be-remembered item, the probability of erroneously accepting an item for the distractor channel, and the probability of erroneously guessing "YES" to a probe item not previously presented on either channel. However, in order to properly assign observations to conditions to compute these scores, it was first necessary to screen out the data from those trials on which a shadowing error occurred simultaneously with presentation of a to-be-remembered item, since compliance with attention directing instructions was assured only while Ss were accurately shadowing the designated channel. This preliminary screening resulted in the loss of slightly less than a third of the total observations. An analysis of variance indicated no systematic relationship between the frequency of these critical shadowing errors and any of the experimental variables. Table 1 lists the mean number of shadowing errors per trial in each of the experimental conditions and the proportion of trials on which one of these errors occurred coincidently with presentation of an item subsequently probed.
TABLE 1

MEAN NUMBER OF SHADOWING ERRORS PER TRIAL AND THE PROPORTION OF TRIALS ON WHICH ONE OF THESE ERRORS OCCURRED SIMULTANEOUSLY WITH THE PRESENTATION OF THE WORD SUBSEQUENTLY PROBED.

<table>
<thead>
<tr>
<th>Probe Type</th>
<th>To Be Remembered Channel</th>
<th>Distractor Channel</th>
<th>To Be Remembered Channel</th>
<th>Distractor Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identity</td>
<td>3.13 (.365)</td>
<td>3.10 (.350)</td>
<td>3.01 (.353)</td>
<td>2.89 (.328)</td>
</tr>
<tr>
<td>Acoustic</td>
<td>3.15 (.328)</td>
<td>3.29 (.285)</td>
<td>2.88 (.260)</td>
<td>3.13 (.328)</td>
</tr>
<tr>
<td>Semantic</td>
<td>3.19 (.328)</td>
<td>3.27 (.258)</td>
<td>3.11 (.230)</td>
<td>3.00 (.360)</td>
</tr>
</tbody>
</table>

Note: Proportion of critical shadowing errors given in parentheses.
TABLE 2

PROBABILITY OF "YES" RESPONSES IN EACH CONDITION
AVERAGED OVER SERIAL POSITION

<table>
<thead>
<tr>
<th></th>
<th>DIVIDED ATTENTION</th>
<th></th>
<th>FOCUSED ATTENTION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Channel</td>
<td></td>
<td>Channel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Probe &quot;Remember&quot;</td>
<td>&quot;Shadow&quot; Catch Type (Distractor) Trials</td>
<td>&quot;Remember &amp; Ignore&quot; Catch Type (Distractor) Trials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>.483</td>
<td>.471</td>
<td>.157</td>
<td>.665</td>
</tr>
<tr>
<td></td>
<td>.542</td>
<td>.476</td>
<td>.228</td>
<td>.776</td>
</tr>
<tr>
<td></td>
<td>.527</td>
<td>.448</td>
<td>.280</td>
<td>.692</td>
</tr>
<tr>
<td></td>
<td>.517</td>
<td>.465</td>
<td>.222</td>
<td>.711</td>
</tr>
</tbody>
</table>
The several recognition probabilities were then computed using the remaining data. Table 2 lists these scores, averaged over serial position. The main effect of Channel and of Instruction were both significant \( F(2,6) = 12.23, p < .01 \), and \( F(1,6) = 16.59, p < .01 \), as was the Channel by Instruction interaction \( F(2,6) = 7.9, p < .05 \). The effects of none of the other variables reached significance in this analysis.

Recalling that "YES" responses to both distractor and catch trial probes constitute false positives, it is apparent from Table 2 that recognition performance in the Focused Attention condition was considerably better than that in the Divided Attention condition. Both the Channel main effect and the Channel x Instruction interaction are useful in identifying the source of this superiority. Consider first the hypothesis that it was only in the Focused Attention condition that any retention was possible; perhaps Ss in the Divided Attention condition were simply unable to retain anything from one channel while shadowing another and so responded to the recognition tests in a random fashion. The fact that on the average Ss in the Divided Attention condition responded correctly to only half of the probes of to-be-remembered items would seem to support this hypothesis. However, the false alarm rate on catch trials mandates its rejection. This false alarm rate indexes Ss tendency to guess "YES" on those trials on which no trace of the probed item could have been available, i.e., trials on which the probed item had not been previously presented on either channel. The significant differences in the proportion of "YES" response to-be-remembered and catch probes in both
the Focused \((q(3,6) = 17.2, p < .01)\) and Divided \((q(3,6) = 14.0 p < .01)\) conditions demonstrates that in both these cases Ss could, on some trials, retain the probed item from the time of its presentation until test.

It is also evident from the catch trial data that Ss in the Divided Attention condition were somewhat more reluctant to respond "YES" than those in the Focused Attention condition. This is consistent with statements made by a number of Divided Attention Ss, who apologized after the session for "being able to remember so few of the words." The extent of this response bias became far more visible when the confidence ratings were analyzed. In Table 2 all "YES" responses were pooled and the confidence ratings ignored. In Table 3 those trials on which Ss checked "PROBABLY YES" or "POSSIBLY YES" have been excluded, so that only the proportion of trials on which Ss responded "CERTAINLY YES" remain.

By comparing the two tables, it is notable that in the Focused Attention condition Ss reported being certain on 74% of the trials on which they correctly responded "YES", whereas for Ss in the Divided Attention condition "certain" responses accounted for only 27% of the correct responses. Clearly, the experimental treatments have influenced Ss' decision strategies and/or response biases as well as their retention of the stimulus words. Since the hypotheses under investigation are concerned with the influence of attentional variables on encoding and memory processes, a measure of recognition performance which is free of these bias effects is desirable. The measure chosen was the area under the
### TABLE 3
PROBABILITY OF "CERTAIN YES" RESPONSES IN EACH CONDITION
AVERAGED OVER SERIAL POSITION

<table>
<thead>
<tr>
<th>Probe Type</th>
<th>DIVIDED ATTENTION Channel</th>
<th>FOCUSED ATTENTION Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot;Remember&quot;</td>
<td>&quot;Shadow&quot; (Distractor)</td>
</tr>
<tr>
<td>TYPE</td>
<td>Trials</td>
<td>Trials</td>
</tr>
<tr>
<td>IDENTITY</td>
<td>.149</td>
<td>.097</td>
</tr>
<tr>
<td>ACOUSTIC</td>
<td>.160</td>
<td>.120</td>
</tr>
<tr>
<td>SEMANTIC</td>
<td>.106</td>
<td>.119</td>
</tr>
<tr>
<td>MEAN</td>
<td>.138</td>
<td>.112</td>
</tr>
<tr>
<td>MEAN</td>
<td>.138</td>
<td>.112</td>
</tr>
</tbody>
</table>
MOC curve ($A_g$), a nonparametric strength measure based on the application of the theory of signal detectability to recognition tasks. This measure makes more efficient use of the confidence rating data than traditional "high threshold" corrections for guessing, and at the same time is free of the distributional assumptions underlying the $d'$ signal detection measure. As typically used, (c.f., Banks, 1970), $A_g$ takes on values between 1.0 (perfect accuracy) and .5 (chance success). Since in this experiment, however, it is possible for the probability of responding "YES" to a distractor to be less than that of responding "YES" to catch trial probe, $A_g$ values between .5 and 0 are also meaningfully defined and indicate Ss have recognized an item as having occurred on the non-tested channel. The remaining contrasts are based on the appropriate $A_g$ scores.

Figures 1 and 2 show the computed $A_g$ values as a function of Instruction, Channel, and input Serial Position. Instruction and Channel main effects were both significant ($F(1.6) = 36.02, p < .01$, and $F(1.6) = 81.2, p < .01$), as was their interaction ($F(1.6) = 23.7, p < .01$). The main effect of position did not reach significance, but its interaction with both Instruction and Channel did ($F(9,54) = 2.78, p < .05$, and $F(9,54) = 8.7, p < .01$). Tests on simple main effects indicated a significant Position effect for both the to-be-remembered and distractor channels in the Divided Attention condition ($F(9,30) = 2.76, p < .05$, and $F(9,30) = 2.78, p < .05$) but no significant effect of the same variable in the Focused Attention condition.
Figure 1. DIVIDED ATTENTION: Mean $A_g$ scores as a function of channel probed and serial position (bars indicate 95% confidence intervals).
Figure 2. FOCUSED ATTENTION: Mean $A_g$ scores as a function of channel probed and serial position (bars indicate 95% confidence intervals).
Consider first the data for the items from the to-be-remembered channels. From the limited capacity assumption of most theories of human information processing one would expect encoding of these items to be interfered with less by their own shadowing (Focused Attention) than by the shadowing of other items (Divided Attention). The upper curves in Figures 1 and 2 clearly support this: retention is significantly (Tukey simultaneous confidence intervals, Winer, 1964) above the $A_g = .5$ chance level at all serial positions. In the Divided Attention condition only the three most recently presented items were recognized at a frequency significantly above chance.

The Instruction x Position interaction is useful in interpreting the superiority of recognition of to-be-remembered items in the Focused Attention condition. A major difference between the task demands facing Ss in the two instructional groups was in the opportunity provided for rehearsal of the to-be-remembered items. In the Focused Attention condition, Ss shadowed the to-be-remembered items: this is formally equivalent to a single overt rehearsal. In the Divided Attention condition Ss shadowed items from the distractor channel: this procedure would seem to prevent rehearsal of to-be-remembered items at least as effectively as the more conventional rehearsal preventing tasks (e.g., counting backwards). The relatively flat serial position curve in the Focused Attention condition, as compared to the rapid decline to the chance level in the Divided Attention condition, is
consistent with this rehearsal differences interpretation. Thus it is tempting to speculate that, with regard to the to-be-remembered items, the "Attentional Instructions" variable amounted to no more than a comparison of filled and unfilled retention intervals. But if rehearsal differences alone accounted for the instructional effect, one would expect no difference between groups in the recognition scores for items presented in the final serial position. Since these items were tested immediately after presentation, the obtained $A_g$ differences at Serial Position 10 (upper curves, Figures 1 & 2) cannot be attributed to differential rates of forgetting. Rather it appears also necessary to conclude that the Divided Attention situation reduced the probability of adequately encoding the to-be-remembered item at the time of its presentation.

Turn next to the data for false recognitions of distractor items (lower curves, Figures 1 and 2). In the Focused Attention condition $S$s did not shadow these items, and the retention test was structured to encourage ignoring them. Any departure from chance ($A_g = .5$) here indicates a limit to $S$s' ability to exclude information. As can be seen in Figure 2, $S$s did exhibit retention of distractor items presented in the last four serial positions. Note, too, that these items, although retained, were not confused with to-be-remembered items: $A_g$ scores below .5 indicate that items from the distractor channel were correctly rejected more often than were catch trial probes.

A similar, though larger, effect is visible in the Divided Attention condition (lower, curve, Figure 1). Here, $S$s had
Figure 3. DIVIDED ATTENTION: Mean $A_g$ scores as a function of probe type, channel probed, and serial position.
Figure 4. FOCUSED ATTENTION: Mean $A_g$ scores as a function of probe type, channel probed, and serial position.
shadowed the distractor channel items. In the final four serial positions correct rejections were more probable than in the Focused Attention condition. In addition, in the Divided Attention condition, some evidence of retention of distractors is exhibited in all but the first three serial positions. Apparently, the act of overtly repeating a distractor both enhances the probability that it will be maintained memorialy and prolongs the period for which it will be maintained.

Consider next the information provided by the probe type variable on the dimensions of encoding of to-be-remembered items. From Bregman's (1968) and Shulman's (1970) results, evidence for both semantic and acoustic encoding was predicted for the Focused Attention condition, with a higher recognition rate for acoustic probes. In accord with Shulman's (1970) proposal that semantic encoding requires more of the available processing capacity than acoustic encoding it was also predicted that the relative contribution of semantic cues should be reduced, if not eliminated, in the Divided Attention condition. To evaluate these predictions the Ag scores for those serial positions at which recognition performance was significantly above chance were partitioned by type of probe employed. Since not all serial positions in the Divided Attention condition were thus included, separate analyses were performed for the Focused and Divided Attention conditions. The Upper curves in Figures 3 and 4 portray the data analyzed.

In the Divided Attention condition (Figure 3) the main effect of Probe Type was significant \( (F(2,36) = 3.74, p < .05) \). Post-hoc comparisons indicated that the recognition scores for semantic
probes were significantly less than those for both acoustic probes \( (q,(2,36) = 4.91, p.< .01) \) and identity probes \( (q(3,36) = 5.43, p < .01) \). The latter two levels of the Probe Type variable did not differ from one another. Thus, as is evident in Figure 3, with the exception of the last item presented, semantic encoding makes virtually no contribution to the recognition of to-be-remembered items in the Divided Attention condition.

In the Focused Attention condition (Figure 4), by contrast, a quite different picture emerges: evidence for a considerable amount of semantic encoding of to-be-remembered items was obtained at all serial positions. Figure 4 also indicates a slight, though consistent, inferiority in responding to semantic, as opposed to acoustic, probes; this effect, however, did not reach significance \( (F(2,36) <1.0) \). It is also noteworthy that, with Probe Type included in the analysis, the main effect of Serial Position was significant \( (F(9,108) = 2.17, p. <.05) \), while the Probe Type x Serial Position interaction was not \( (F(18,90) <1.0) \). Thus, while some forgetting of to-be-remembered items did occur at the longer retention intervals, the rate of forgetting was independent of the type of information tested.

Finally, consider the encoding of those items which were retained from the distractor channels. The lower curves in Figures 3 and 4 show the relevant data. The main effect of Probe Type was significant in both the Divided and the Focused Attention conditions \( (F(2,54) = 4.18, p <.05, \text{ and } F(2,36) = 3.33, p. <.05) \). The effect of Serial Position was also significant in the Divided
Attention condition \( f(5,54) = 4.16, p < .05 \). Post-hoc comparisons indicated that in the Divided Attention condition the correct rejection rate was significantly different from chance in the final three serial positions for all probe types, and that there was a lower correct rejection rate for semantic probes than for acoustic or identity probes, which did not differ from one another. In serial positions 4 through 7 the recognition rate for semantic probes did not differ from chance. In the Focused Attention condition, only the acoustic and identity probes differed significantly from the \( Ag = .5 \) chance level. Again, these two conditions did not differ from one another.

Thus, in the Divided Attention condition, the task of shadowing the distractor list appears to have resulted in the establishment of a trace which includes semantic, as well as acoustic, information. In the Focused Attention condition, Ss appeared to have been unable to comply fully with suggestion that they "ignore" the distractor lists. Despite the attentional demands imposed by the task of shadowing and attempting to remember the items from the other channel, sufficient information was encoded from the distractor channel to permit the recognition of the sounds of the most recent words. In this case, however, no evidence for semantic encoding was obtained.
DISCUSSION

In the Introduction it was proposed that the strategy which S adopts in distributing his attention over two concurrent inputs may produce substantial differences in the encoding and retention of each. The above results reveal at least four such effects of some importance. First, from the data on the recognition of to-be-remembered items in the Divided Attention condition (Figure 1) it may be concluded that the intent to remember material from a given source may itself constitute a condition sufficient to support some retention, even when distracting events prevent focusing one's attention on that source. Secondly, from the data on the recognition of distractors in both groups (Figures 1 and 2) it is equally evident that this intent to retain is not a necessary condition. Even in the Focused Attention conditions, which was structured to encourage and permit Ss to totally ignore the distractors, some retention of the most recent distractor items was clearly indicated. In the Divided Attention condition, in which Ss were forced to devote sufficient attention to the distractor channel to support its shadowing, the chances that an item from that channel would be subsequently recognized were substantially increased. Finally, the Probe Type data (Figures 3 and 4) support previous findings that semantic, as well as acoustic, encoding is possible in short term memory. In addition, however, these same data also indicate that
rehearsal, not simply the focus of attention or the overall information load, determines whether semantic encoding will, in fact, take place. Each of these major conclusions is of some consequence in understanding the processes of attending and encoding.

The data in Figures 1 and 2 confirm Norman's (1969) conclusion that verbal material presented on a non-shadowed channel does enter short term memory. Subjects in the Divided Attention condition of the present experiment worked under instructions equivalent to those given Ss in Norman's "memory while shadowing" group: shadow material on one channel carefully, while attempting to retain the material on the other. In fact, there is a striking resemblance between the appropriate comparison data in this experiment (upper curve, Figure 1) and Norman's data. Both experiments found substantial, though hardly error free, recognition of the most recently presented items which declined steadily with serial position, reaching the chance level for the fourth item back. This latter detail, that in both studies only the last four non-shadowed items were retained, may be of some interest, since the two item per second presentation rate used here was twice as fast as that in Norman's study. The implication, which clearly requires more direct test, is that Ss ability to store non-shadowed information may be item, as well as time, limited.

Norman (1969) explained the discrepancy between his demonstration of retention of non-shadowed material and the negative results of previous studies in terms of his use of an
immediate retention test. In the Introduction of this study it was objected that this difference might rather have been due simply to the fact that Norman, unlike previous Es, encouraged his Ss to attempt to remember the non-shadowed material. In light of the data from the Focused Attention condition of this experiment, however, that alternative explanation no longer appears tenable. As the lower curve in Figure 2 shows, Ss retained information about the contents of the non-shadowed channel even when every effort was made to encourage them to ignore that channel. The same data also indicated that the non-shadowed items were encoded in such a way as to permit their differentiation from shadowed items. Since the false positive rate for these items was significantly below chance, it appears that these items were not only entered into short term memory, but also tagged as to their channel of origin. Note, too, that here again retention of non-shadowed input was limited to the last four items presented.

While these results do replicate and extend Norman's (1969) findings, they no more constitute support for his "late selection" model of attention than do his own data. For, while it is true that a theory of attention which holds that "selection takes place with the aid of both meaningful and physical properties" (1969, p. 85) does predict memory for all events, even those to which we fail to attend, it does not follow that memory for non-attended events implies that they have been analyzed for meaning. The Probe Type variable in the present experiment does, however, provide evidence about the level of processing which occurs prior to selection,
and the results from the use of semantic probes argues strongly against a late selection approach.

From Figures 3 and 4 it is notable that in the Divided Attention condition semantic information about non-shadowed material contributed to the overall recognition rate only for the last item presented. In the Focused Attention condition there was no evidence at all for semantic recognition of those distractor items which were retained. If these items had been analyzed for meaning prior to selection, why were Ss unable to use the information provided by this analysis in an immediate test? Nor can it be readily argued that semantic information was extracted but not stored. The recognition scores for semantic probes of to-be-remembered items in the Focused Attention condition confirm Bregman's (1968) and Shulman's (1970) demonstration that, when required, semantic information can be maintained in short term memory. Indeed, as in these previous studies, Figure 4 indicated that although retention of semantic information is slightly inferior to that of acoustic information the time course of forgetting of both types of information is much the same. From these data, then, it appears that the encoding of semantic information follows selection of an input, as the early selection models assert. In the Focused Attention condition some information was retained from both channels, but knowledge of the meaning of the material was limited exclusively to the attended ear.

The data from the Divided Attention condition provide further information for determining the boundary conditions for semantic
encoding. Recall that Shulman (1970) proposed that semantic encoding is a relatively time consuming process, which Ss may tend to neglect when required to perform some other activity during the presentation or retention interval. In particular, he singled out rehearsal as one such activity which ordinarily might take precedence over semantic encoding. The data on the retention of to-be-remembered items in Figure 3 support the basic notion of time dependent encoding. When required to shadow material from another source, semantic encoding of to-be-remembered items was completely neglected for all but the last item. However, the data in the same figure on the correct rejection of distractors seriously questions Shulman's designation of rehearsal of an item as an activity which might preclude its semantic encoding. Notice that Ss did store semantic information about the shadowed distractor items, even though all the test probes referred only to the contents of the other channel. To the extent that it is reasonable to liken shadowing to overt rehearsal, it appears that rehearsal facilitates, rather than competes with, semantic encoding. In fact, looking across the four sets of functions in Figures 3 and 4 it can be seen that, although designating a set of items as those to be remembered did not insure semantic encoding of those items, requiring Ss to shadow a set of items did. Thus the present data suggests that semantic encoding is a by-product of rehearsal, rather than an alternative to it.

Posner and Warren (1972) have recently proposed an approach to the relationship between encoding and attention which seems
useful in attempting to identify the implications of the above results for our understanding of human information processing. Basically, they argue that multidimensional theories of encoding need to distinguish between that restricted set of well learned coding operations that do not require direct involvement of the central processing mechanism ("automatic processes") and the much wider range of more complex coding schemes ("conscious processes") that do. Only that latter set of operations are constrained by Ss limited capacity. Posner and Warren go on to suggest that rehearsal is one activity which requires "conscious" processing of an item. It may now be concluded that the present experiment has identified shadowing as another such activity. Thus, the acoustic encoding evidenced in all conditions may be considered to have proceeded automatically. Hence S encoded the sound of an item regardless of his intent to remember it. However, when S was required to shadow an item, he was obliged to admit that item to the limited capacity conscious processor and, having done so, proceeded to encode it semantically as well. It might be noted that this distinction between automatic and conscious processes is in accord with the spontaneous comments of Ss in both groups who reported that they "felt like they didn't know what had been said" on the non-shadowed channel. The proposition that rehearsal requires admission of an item to the central processing channel may also help to explain the indication that the final non-shadowed item was encoded semantically if the assumption is made that at the beginning of the eight second test interval Ss rehearsed the
last item presented. This last assumption might be tested by having the shadowing task continue beyond the presentation of the last to-be-remembered item.
Ss were given the instructions in three parts: Part 1 prior to practicing the recognition task, Part 2 prior to practicing the shadowing task, and Part 3 prior to the first experimental trial. Parts 1 and 2 did not differ between groups, Part 3 differed only in the designation of which channel was to be remembered. Instructions were read verbatim as follows.

Part 1

"This is an experiment concerned with both attention, or concentration, and memory. In the course of the experiment you'll be asked to listen to short lists of common words, and asked to do various things which will test your ability to remember them and/or to concentrate on them in the presence of distraction. Here's an example of the type of list you'll be working with." (PLAY ONE LIST) "Now, the first of the things you'll be asked to do is a test of how well you can remember what words were in the list immediately after you've heard it. What I'll do is have you listen to a list and then give you an index card on which is asked a single test question on which is asked a question about the contents of that list. These questions may be any one of three types; in the first type, the index card will simply have a word listed on top and you're to indicate whether that word occurred in the list. Here's an example of that type of test card." (SHOW S AN IDENTITY SAMPLE) "When you're given this type of test card after a trial, I simply want you to indicate whether the word shown was in the list you'd just heard. At the same time, you're to indicate how confident you are in your answer: sometimes you'll probably be certain that the correct answer is yes that word was in the list or no you're certain it wasn't. At other times you may feel that your answer is probably right, but have some doubt; while at still other times you may feel that while your answer may possibly be right it's little more than an educated guess. So in checking yes or no we want you to indicate your confidence in your answer by placing your check mark over the adjective that best describes how sure you are. Any questions so far?" "Now, I said that there were three types of test cards. On the second type of test you'll be shown a word and asked to indicate whether it sounds like a
word in the list you've just heard. Here's an example of that type of test" (SHOW S AN ACOUSTIC SAMPLE) "Now when we say 'sounds like' we mean words like 'peg' and 'leg' or 'ignore' and 'before,' which are about as far apart in sound as any two words we'd use and still expect a YES answer to a 'sounds like' question. Note that here too we want you to indicate your confidence in your answer just as before. On the third type of test card you'll be shown a word and asked to indicate whether it means the same thing as a word in the list (SHOW S A SAMPLE). Examples here might be 'evil' and 'wicked' or 'nation' and 'country.' Just as with the sound alike words we've tried to choose words here that are quite close to one another. We're not trying to trick you; in particular we don't expect a YES answer to means the same question on the basis of two words that are only remotely related in meaning."

"So, there are these three types of test cards; identity, sounds alike, and means the same. After any given list, you'll only be asked one question. You won't know the type of question beforehand, and the order in which the types of questions will be asked is completely random from one trial to another. As you hear the list, you should try to prepare for each of the question types as best as you can. One more thing: in the course of the experiment I'll be testing words from all places in the list; on one trial the word tested might be the first word, on another it might be the last, or from somewhere in the middle. So try to remember the whole list until you get the test card. Questions?"

Part 2 - Shadowing Practice

"Now we'll set the memory task aside for a while and introduce you to another task, called "shadowing." In this task you'll be played lists just like the ones you've been listening to, only now, instead of simply listening to the words, we want you to repeat each word back as you hear it. A demonstration is probably the easiest way to show you what I mean.1 (E SHADOWS THE FIRST PRACTICE TRIAL)

"Many people say that this seems like an impossible task at first, but with surprisingly little practice learn to do it quite well. A few suggestions: try to relax, and don't be upset if you have trouble at first; almost everybody does. You'll notice that every trial starts the same way, that is, "Ready, A,B" (or "Ready, 1,2"); it may help to pick up the rhythm if you shadow these words too. Tapping your foot might also help. Questions?" (E TAKES S TO 2 SUCCESSIVE 8 OUT OF 10 CORRECT TRIALS)

"You've picked that up pretty well. Now we're going to make the shadowing task somewhat harder, by playing another list of words to your other ear while you continue to shadow those on your right (left) ear. Here again, this may seem impossible at first, but can be mastered with a little practice if you really try. One thing it may help you to know: you've noticed that all the lists you've been shadowing start with "A,B" ("1,2"); the words I'll be presenting to the other ear are recorded in the same voice, but
all those lists start "1,2" (a,b). It's going to take more concentration to shadow your right (left) ear now, without saying the words from the other ear; but as I said with a little practice I think you'll find it can be done. Questions?" (E TAKES S TO 2 SUCCESSIVE 8 OUT OF 10 DICHOTIC TRIALS)

Part 3 - Experimental Task

Note: Text as given was used for the Divided Attention group, For Focused Attention Ss underlined words were replaced with those in parentheses.

"Now we come to the final, and most important part of the experiment. From here on, you're to continue shadowing just as you have been. But in addition, after each trial, I'll present you with a memory test card about the words in the ear that you were not (were) shadowing. Just as before, these cards may be any one of three types: 'identity,' 'sounds alike,' or 'means the same.' Just as before, you won't know beforehand which type of test card will be given."

"A few points require special emphasis. First, you should consider shadowing as your primary task. That is, for the memory test to have any value to us, you must continue to shadow the words in your right (left) ear as well as you can. We realize that doing the memory task too might not be easy; all we expect is that you make your answers as accurate as you can."

"Secondly, remember that the memory test cards apply only to the words presented to the non-shadowed (shadowed) ear. On some trials a word which seems to fit the test card requirements may have been presented on the shadowed (non-shadowed) channel. But these words are not the ones to which the test cards refer, and so the correct answer in that case would be NO."

"For example, if you were given an identity test of the word 'doctor' we want to know if you remember that word having been presented to the non-shadowed (shadowed) ear. If it was, the correct answer, of course, is YES. But if 'doctor' happened to have been presented to the shadowed (non-shadowed) ear, the correct answer would be NO, just as NO would be correct if 'doctor' had not been presented at all.

"Once again, remember (1) you must continue to shadow as well as you can (2) the test cards refer only to the words in the non-shadowed (shadowed) ear. We'll be doing this for about 20 minutes, and I'll give you a short break about half way through. Questions?"
REFERENCES


