Journal of Experimental Psychology:
Learning, Memory, and Cognition
1995, Vol. 21, No. 1, 255–260

0278-7393/95/$3.00

OBSERVATION

The Cocktail Party Phenomenon Revisited: How Frequent Are Attention Shifts to One's Name in an Irrelevant Auditory Channel?

Noelle Wood and Nelson Cowan
University of Missouri—Columbia

N. Moray's (1959) well-known study of the "cocktail party phenomenon" suggested that participants sometimes notice their name embedded in an ignored auditory channel. However, the empirical finding was preliminary in nature and never has been directly replicated. This was done with improved methodological controls, and the relationship between on-line attention shifts to one's name and subsequent recollection of the name in a sample of 34 undergraduates was examined. Similar to N. Moray, only 34.6% of the participants recalled hearing their name in the channel to be ignored. Only those participants showed on-line evidence of attention shifts, and those shifts occurred only for the two items following the name. The results suggest that participants who detected their name monitored the irrelevant channel for a short time afterward.

According to the well-known "cocktail party phenomenon" (Cherry, 1953) one can attend to only one voice in a crowd at any one moment; yet a stimulus highly pertinent to one's self-interests, such as one's name, supposedly can capture this singular focus of attention when pronounced by an unattended speaker. However, the only empirical test of the ability to detect one's name spoken in an irrelevant channel (Moray, 1959) was conducted rather casually and involved only 12 participants. The detection rate was only 33%, a point that often is overlooked (e.g., Loftus, 1974). The field's considerable interest in this phenomenon as a practical illustration of attentional processes has not been matched by the appropriate follow-up research.

Given the limitations of Moray's (1959) study (to be described), the true rate of detection of the name is unknown. This rate is of considerable theoretical significance. According to strict "early filter" conceptions of attention (e.g., Broadbent, 1958; Cherry, 1953), the name should be detected only on occasional trials in which the participant's attention has wandered to the irrelevant channel. On the other hand, according to strict "late-filter" conceptions (e.g., Corteen & Wood, 1972; Deutsch & Deutsch, 1963; Lewis, 1970; MacKay, 1973), participants would be expected to notice the name routinely and would fail to report the name only on trials in which it was somehow forgotten by the time of the retrospective report. Finally, according to an "attenuating-filter" notion (Treisman, 1960, 1964), the name should activate the appropriate lexical unit in memory only weakly, so that some participants may detect it automatically, but the overall proportion of participants detecting the name cannot be predicted a priori.

Because of limitations in Moray's (1959) method, we replicated the phenomenon using both an on-line measure of attention and retrospective reports. Moray's original method had participants repeating, or "shadowing," a short prose passage recorded in a male voice in a monotone and played to one ear, while ignoring another, similarly constructed prose passage played to the other ear. In the irrelevant, nonshadowed channel, a phrase with the participant's name followed by some instructions was inserted at two points (e.g., "John Smith, you may stop now" and "John Smith, change to your other ear"). Participants rarely followed the directions even when they noticed them, so Moray depended on retrospective reports, through which it was learned that 4 of 12, or 33%, of the participants heard their name on both the first and second presentations (Moray, 1959, Table IV, p. 58). A third, forewarned presentation was reported as being detected by 80% of the participants and probably should be viewed as a divided attention condition.

Some aspects of Moray's (1959) methodology could have inflated the probability of a participant detecting his or her name in the irrelevant channel, whereas other aspects could have decreased this probability. First, both channels were presented in the same male speaker's voice. Inasmuch as selective attention depends heavily on physical (e.g., voice) differences between channels (Cherry, 1953), participants had to rely on spatial location, a cue that is not always used perfectly (e.g., Gray & Wedderburn, 1960). It is possible that some of Moray's participants could not shadow one channel while fully ignoring the other.

Second, though the passages were spoken in a monotone and intensity was measured, some sort of acoustical change or transient still could have been introduced when the participant's name was recorded onto the audiotape. One could

Noelle Wood and Nelson Cowan, Department of Psychology, University of Missouri—Columbia.

This research was supported by National Institutes of Health Grant HD-21338. We thank Ira Fischler, Gordon Logan, Neville Moray, and George Wolford for helpful comments.

Correspondence concerning this article should be addressed to Nelson Cowan, Department of Psychology, 210 McAlester Hall, University of Missouri, Columbia, Missouri 65211. Electronic mail may be sent via Internet to psycowan@MIZZOU1.missouri.edu.

presume that such acoustical irregularities might have attracted the attention even of listeners who had other names.

Third, Moray (1959) does not specify how long a participant shadowed before his or her name occurred in the irrelevant channel. It is important that participants are sufficiently practiced so that the shadowing task is smoothly and effectively performed, thereby minimizing distractions from the irrelevant channel (e.g., Treisman, Squire, & Green, 1974).

Fourth, Moray's (1959) report left unspecified the duration for which participants shadowed between the presentation of the name and the retrospective report. It is possible that, in some cases, names were detected or noticed at some level but not reported because the incident could not be retrieved later, at the time of the retrospective report.

A fifth and final point is that there was no on-line index of the direction of attention. An on-line measure can help to assess whether attention shifts before or after the name presentation (if at all). Shifts just before the name in participants who detect their name would indicate that those participants actually were attending to the irrelevant channel at the time the name was presented, as some researchers (e.g., Holender, 1986) have suggested. Shifts afterward, on the other hand, would indicate that the name itself affected attention.

To address these issues, we departed from the method of Moray (1959) in several ways. To raise the degree of attentional control, words on the irrelevant and to-be-shadowed auditory channels were presented in different voices and were synchronized. We presented only the participants' first names with no subsequent command and, as an acoustical control, we tested participants in yoked pairs. Each participant received his or her own name at one of two predesignated points within the irrelevant speech passage and received the yoked control participant's name at the other point. Furthermore, by using computer-digitized speech, we were able to use the same recording heard in both stimulus channels for every participant, with the exception that two of the words were replaced with names for pairs of participants. (It is only recently that computer technology has made feasible such long digitally stored sequences.) These precautions should remove any concern about confounding acoustical factors.

To achieve sufficient practice in shadowing, each participant shadowed continuously for 4 min before a name occurred in the irrelevant channel, with the second name occurring after 5 min. Pilot results had suggested that this was long enough to permit shadowing errors to decline to an asymptotically low level. Retrospective reports were obtained 30 s (for 5-min names) or 90 s (for 4-min names) after the name was presented.

Finally, to investigate the possibility that participants shifted attention to the irrelevant channel around the time that their name occurred, we recorded participants' responses and examined both errors in shadowing and stimulus–response lags for correct shadowing responses. The assumption was that a shift of attention away from the channel to be shadowed often results in errors or delays in shadowing. Similar measures have been used successfully in previous studies of selective listening, though not in conjunction with the presentation of participants' names (Barr & Kapadnis, 1986; Corteen & Wood, 1972; Cowan, Lichty, & Grove, 1990; Dawson & Schell, 1982; Treisman & Geffen, 1967; Yates & Thul, 1979). For example, Cowan et al. (1990, Experiment 4) found that the identification of the most recent syllable in an irrelevant spoken channel was better on trials in which there was a brief pause or error in performance of the primary task (reading in a whisper) concurrent with the syllable presentation, though forgetting still occurred as the task-filled test delay was extended across 10 s.

Method

Participants

Only native English speakers with monosyllabic first names and with no known hearing impairments were recruited to be participants. The sample included 34 undergraduate students (25 male, 9 female) from introductory psychology courses who received course credit for their participation. Nine additional participants were excluded: 3 because of excessive shadowing errors (greater than 15% of all words were missed), 1 because of an experimenter error, and 5 because we lacked yoked control participants.

All participants shadowed the same attended channel but were randomly assigned to one of three irrelevant channel conditions: a control condition in which the irrelevant channel contained nonrelated, monosyllabic words but no names ($n = 8$), or experimental conditions in which the participant's name occurred after 4 min ($n = 13$) or 5 min ($n = 13$) of shadowing. Any participant who received his or her own name at 4 (or 5) min also received a yoked participant's name at 5 (or 4) min.

Apparatus

All auditory stimuli were initially recorded on one channel of a four-channel, reel-to-reel audiotape deck in a sound attenuation chamber. Then the stimuli were digitized on a Macintosh II computer (Apple Computer, Inc., Cupertino, CA) with Sound Designer II (Digidesign Corp., Menlo Park, CA) software at a sampling rate of 22 kHz with a dynamic resolution of 16 bits.

Participants were tested individually in the sound-attenuated chamber. The auditory stimuli were presented through stereo audiological headphones. Levels of intensity of stimuli in both ears were set to a range of 65–70 dB(A) with a Model 1551-C sound level meter (GenRad Corp., Concord, MA) equipped with a 9A Type Earphone Coupler. Participants spoke into a microphone and their speech was recorded on one channel of the reel-to-reel tape deck, while the attended and irrelevant channels were transferred to two other channels of the same tape deck.

Stimuli

The spoken stimuli included 630 unrelated, monosyllabic English words with a frequency in the language of at least 15 per million words of text according to Thorndike and Lorge (1944). The attended channel consisted of 330 of those words recorded in a female voice in a monotone at a rate of 60 words per minute. The irrelevant channel included the other 300 words, recorded in a male voice in a monotone at the same rate, with the onsets of words in the two channels synchronized. The attended channel began 30 s prior to the irrelevant channel to allow a short practice period without distraction, and both channels ended together after 5.5 min. Participants' names were recorded in the same male voice and were digitally inserted into the irrelevant channel after 4 and 5 min of shadowing, each name replacing a word. The order of words was otherwise identical across participants.

Procedure

Participants were informed that the primary task was to listen to the right ear and repeat each word as soon as it was heard, without errors if possible. They were told that the left-ear sounds were simple distractors that were to be ignored. Participants were asked to continue shadowing until all sounds on the attended channel stopped, and then to turn a questionnaire packet right side up and complete it.

The questionnaire included a series of queries, one per page, about the irrelevant channel. Participants reported any of the content they could remember, noted if anything unusual was heard, decided whether there were any names presented, and answered whether they had heard their own name. Finally, participants estimated how many times, if any, their attention wandered to the irrelevant channel, and explained why they thought that this may have occurred. Participants were asked to fill out the questions in the order presented.

Results

Questionnaire Items

Whereas Moray (1959) reported that none of his participants were able to recall any word from the irrelevant channel, 14.7% of our participants recalled a specific word such as *left* or *praise* when asked about the content of the irrelevant channel. Also, 38.2% volunteered the information that the channel was presented in a male voice. This is consistent with the well-known finding that participants are more likely to detect the voice of an ignored channel than its verbal content (Cherry, 1953; Moray, 1959; Mowbray, 1964; Treisman, 1964; Treisman & Riley, 1969).

According to the retrospective questionnaire, only 34.6% of the participants whose names were presented in the irrelevant channel (5 from the 4-min and 4 from the 5-min condition) recalled hearing their name. This is quite similar to what Moray (1959) obtained (33%). A Fisher's exact test suggested that there was no difference between the 4-min and 5-min conditions in this regard ($p = .50$). Furthermore, no participant in the no-name control condition reported hearing a name, and no participant reported hearing a yoked control participant's name.

As another control for stimulus factors, we compared the results from multiple participants with the same name. The shared names and the results for participants with those names, in the format (number who noticed the name, number who did not notice), were Chris (1, 2), John (1, 2), Kim (1, 1), Mike (0, 3), and Scott (1, 1), for a total of 4 participants who noticed their names and 9 who did not. This proportion (30.8%) was similar to the overall experimental result. Among the remaining participants, there was no obvious difference between the names of those who noticed their name (Claire, Jane, Jill, Neal, and Sean) and those who did not (Beth, Bill, Dave, Jeff, Mark, Pat, Sue, and Tim).

In response to the question regarding attention shifts, only 3 participants claimed that their attention never wandered (1 participant from each condition). The reported average estimate of the number of attention shifts during the shadowing session was low, however, at 3.7. Participants' most commonly reported reasons for shifting attention were that they simply lost their concentration and were distracted, or that they were curious about the irrelevant channel. Finally, the participants who did versus did not recall hearing their name in the irrelevant channel did not differ significantly on any of the other aforementioned questionnaire items.

Shadowing Errors and Lags

To examine shadowing practice effects, errors within the first 4 min of shadowing (i.e., up to the point of the first name) were marked for any word that was omitted or severely mispronounced (with an alteration in more than one phoneme). Using 30-s periods of shadowing, the mean numbers of errors per time period were 0.35, 2.41, 1.79, 1.38, 1.03, 1.09, 1.47, and 1.65. The first data point was the lowest, undoubtedly because the irrelevant channel did not begin until after 30 s of shadowing. A one-way, repeated measures analysis of variance (ANOVA) of these data for all participants revealed a significant effect of time period, $F(7, 231) = 5.36$, $MSE = 2.34$, $p < .001$. Newman–Keuls pairwise tests between means indicated that the number of errors in the first time period was significantly lower than in all other time periods except the fifth and sixth out of eight ($ps < .05$). More important, demonstrating a practice effect, errors in the second time period (i.e., the first in which two channels were present) were significantly higher than in the fourth, fifth, and sixth time periods ($ps < .05$). No other pairwise tests were significant.

Another ANOVA was carried out on data for just those participants who received names, with later recall of the participant's own name (recalled versus did not recall) as a between-subjects factor and time period as a within-subject factor. There was again an effect of time period, $F(7, 168) = 4.13$, $MSE = 2.62$, $p < .001$, but no effect of participant group. Across the entire session, on the average, participants who noticed their name made 17.0 errors and participants who did not notice their name made 20.5 errors, a nonsignificant difference. Thus, there was no evidence of a gross difference in shadowing performance between participants who did versus did not recall hearing their name.

Errors and delays in shadowing around the time that a name was presented in the irrelevant channel were considered to be of critical importance as indexes of potential momentary shifts of attention. Shadowing latencies were measured on the computer screen, as the interval from the shadowed stimulus onset to the response onset, with an oscillographic representation of the shadowing responses that was produced using the sound editing software described above. For these detailed analyses, based on pilot data, a temporal window of analysis was adopted that included two words before the name, the name itself, and three words after the name.

In Figure 1, the percentages of participants displaying errors in shadowing during the window of analysis are plotted. The figure shows that attention shifts occurred shortly after the participant's name, but only in those participants who later recalled hearing their name. To begin to confirm statistically that recall of one's name was related to on-line evidence of attention shifts, we coded a correct shadowing response as 0 and an error as 1. We then entered these scores into an

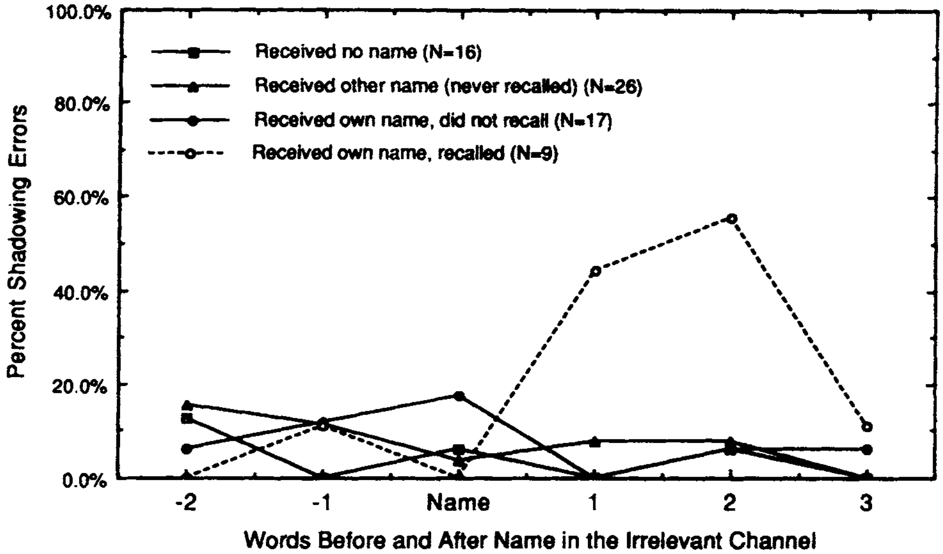

Figure 1. Mean percentage of participants making errors in shadowing for the word synchronized with a name in the irrelevant channel and for the two preceding and three following words. Data are combined across stimuli occurring after 4 and 5 min of shadowing. Separate data lines are shown for the no-name control participants (8 participants × 2 observation periods, specifically the periods where the other participants received names) and for experimental participants in the periods surrounding a yoked participant's name (which never was recalled), and in the periods surrounding the participant's own name, for those who did not versus did later recall hearing the name.

ANOVA for participants who received names, with recall of versus failure to recall the participant's own name as a between-subjects variable and the serial position of the word (−2, −1, name, +1, +2, +3) as a within-subject variable. This ANOVA yielded not only an effect of the serial position, $F(5, 120) = 3.23$, $MSE = 0.078$, $p < .009$, but also a significant interaction between the variables, $F(5, 120) = 5.87$, $MSE = 0.078$, $p < .001$. Separate ANOVAs for each of the six serial positions indicated that the participants who recalled hearing their name made significantly more errors than participants who did not on the word following the name (+1), $F(1, 128) = 12.60$, $MSE = 0.092$, $p < .001$, and on the word after that (+2), $F(1, 128) = 15.74$, $MSE = 0.092$, $p < .001$, whereas none of the other words produced a significant difference between groups. Because the error scores were binary, a series of Fisher's exact tests also was conducted, and it further confirmed that noticing one's name was related to shadowing disruptions only for the two words immediately following the name in the irrelevant channel (for the six serial positions tested, $p > .6$, $p > .7$, $p > .2$, $p < .009$, $p < .01$, and $p > .5$, respectively).

It was not possible to measure shadowing response lags (reaction times) for all participants, given that many of the errors were omissions. However, we examined response lags for all participants who remained errorless throughout the six-word analysis window. The number of errorless observations and the mean lags are shown in Figure 2. It is clear from the figure that these lags closely resemble the findings of the error analysis. Specifically, there was a temporary increase in shadowing lags after the presentation of a name only among those participants who later recalled hearing their name in the *irrelevant channel.* To confirm statistically that this was the case, we conducted an ANOVA on data from participants who received names and did versus did not recall their own name, with the serial position within the observation period (1–6) as a within-subject factor. This analysis produced only one significant effect: a Group × Serial Position interaction, $F(5, 70) = 2.99$, $MSE = 23{,}472$, $p < .02$. Follow-up ANOVAs at each serial position separately revealed a group difference for the second word following the name (+2), $F(1, 46) = 5.79$, $MSE = 39{,}349$, $p < .02$, but not for any of the other five words in the analysis window.

The presence of attention shifts in the postname period appeared to be consistent among participants who later recalled hearing their name. For all 4 participants who made no shadowing errors in the analysis period but later recalled hearing their name, there was at least one shadowing latency among the three words following the name (+1, +2, +3) that was at least 50 ms higher than the latencies of responses to any of the previous three words (−2, −1, name). That was true for only 2 of the 12 errorless participants who did not recall hearing their name. This difference between participants who did and did not detect their name was significant by a Fisher's exact test ($p < .01$).

Discussion

We found that 34.6% of the participants recalled hearing their name in a task-irrelevant channel, which was quite comparable to the 33.3% that Moray (1959) found. The close correspondence between these results could be coincidental, given the small sample size that Moray used. However, an important aspect of the behavioral results in both studies is

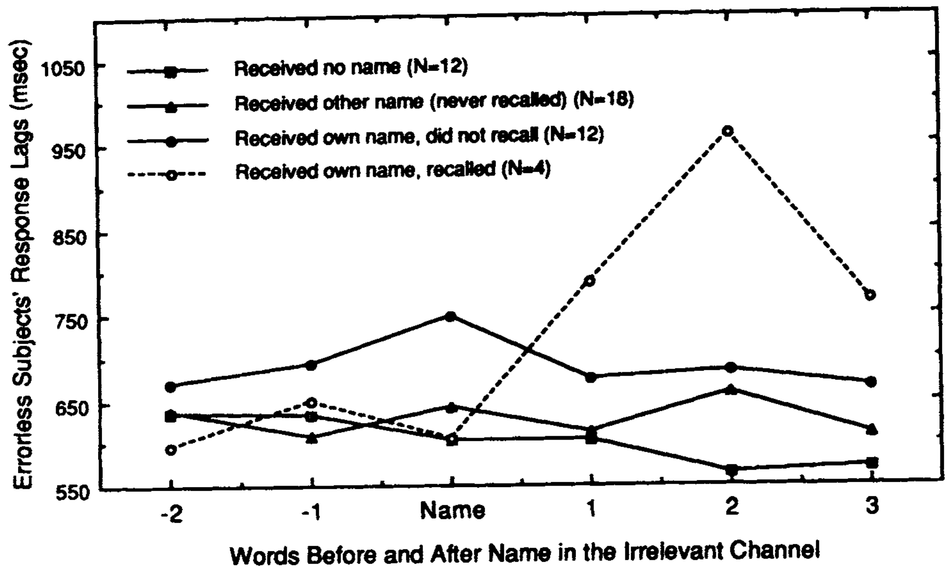

Figure 2. Mean response lags (stimulus onset to response onset times) for just those participants who made no shadowing errors to the word synchronized with a name in the irrelevant channel, to the two preceding words, or to the three following words. Separate data lines are shown for the no-name control participants (6 participants × 2 observation periods, specifically the periods where the other participants received names) and for experimental participants in the periods surrounding a yoked participant's name (which never was recalled), and in the periods surrounding the participant's own name, for those who did not versus did later recall hearing the name.

that some participants noticed the name. This might be more impressive in our study because we used a selective listening task with distinctly different voices in the left and right channels, which should have minimized the difficulty of ignoring the irrelevant channel. It also is important that many participants failed to notice their name.

We examined errors and increased lags in shadowing as on-line measures of attention shifting. There was no evidence of group differences before the presentation of the participant's name, but participants who later recalled hearing their name displayed increased errors and response lags to the two words following the name. This finding is similar to what has been observed with other semantic information (e.g., Yates & Thul, 1979).

On the other hand, participants who recalled their name did not display errors or increased lags on the word synchronized with the name itself. In contrast to that result, impairment of the response to the item presented along with the critical distractor was observed in a visual analog to the present task (Wolford & Morrison, 1980) in which two digits to be compared for an odd–even parity decision were presented flanking a word that was to be ignored, and this word sometimes was the participant's last name. Number-comparison responses were slower for number pairs flanking the participant's name than for number pairs flanking other words. However, in that visual procedure, the name might well have been recognized more immediately because it could not be fully excluded from the visual focus of attention, given its central location between the targets to be attended. Also, there might have been more time to recognize the name before executing the response to the relevant task stimuli, inasmuch as reaction times to the task in Wolford and Morrison's study were considerably longer than the reaction times in the present study.

The shadowing task measurements help to constrain interpretations of the memory data. One interpretation, consistent with an early filter theory, would be that participants intermittently sample the irrelevant channel and that those who happen to do so when the name arrives are the ones who notice the name (e.g., see Holender, 1986). Arguing against this interpretation, however, the disruption in shadowing in participants who recalled hearing their name occurred shortly after the name, but not before. Therefore, this disruption in shadowing appears to have resulted from a recruitment of attention by the name.

We cannot claim that the name was detected without any attention to the irrelevant channel, inasmuch as a subtle division of attention might not show up in the shadowing measure. However, attention to the irrelevant channel at best must have been slight, given the modest percentage of name detection.

Holender (1986) called into question all existing evidence for semantic activation without accompanying conscious identification of the stimulus causing the activation. His theoretical position permits that the conscious identification could occur as a result, rather than a cause, of the semantic activation. In this light our results are consistent with his suggestions, inasmuch as conscious identification (as indexed by subsequent report of the name) was accompanied consistently by an observable attention shift within a few seconds after the name.

Given that only about a third of the participants detected their names and that detection occurred without evidence of participants' sampling the irrelevant channel, the results seem most consistent with an attenuating-filter theory (Treisman, 1960, 1964) or any similar intermediate-level filter theory (Cowan, 1988). Though an extreme late-filter theory cannot be completely ruled out on the basis of our results, recent physiological evidence tends to militate against a late-filter theory (e.g., Hackley, 1993; Näätänen, 1992). The present report illustrates the potential importance of some classical behavioral procedures for investigating attention, provided that they are reexamined with sufficient care.

References

Barr, R. A., & Kapadnis, C. D. (1986). Some observed differences in degree of concentration and their effects on shadowing. *Quarterly Journal of Experimental Psychology, 38A,* 249–270.

Broadbent, D. E. (1958). *Perception and communication.* London: Pergamon.

Cherry, E. C. (1953). Some experiments on the recognition of speech, with one and two ears. *Journal of the Acoustical Society of America, 25,* 975–979.

Corteen, R. S., & Wood, B. (1972). Autonomic responses to shock-associated words in an unattended channel. *Journal of Experimental Psychology, 94,* 308–313.

Cowan, N. (1988). Evolving conceptions of memory storage, selective attention, and their mutual constraints within the human information-processing system. *Psychological Bulletin, 104,* 163–191.

Cowan, N., Lichty, W., & Grove, T. R. (1990). Properties of memory for unattended spoken syllables. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16,* 258–269.

Dawson, M. E., & Schell, A. M. (1982). Electrodermal responses to attended and nonattended significant stimuli during dichotic listening. *Journal of Experimental Psychology: Human Perception and Performance, 8,* 315–324.

Deutsch, J. A., & Deutsch, D. (1963). Attention: Some theoretical considerations. *Psychological Review, 70,* 80–90.

Gray, J. A., & Wedderburn, A. A. I. (1960). Grouping strategies with simultaneous stimuli. *Quarterly Journal of Experimental Psychology, 12,* 180–184.

Hackley, S. (1993). An evaluation of the automaticity of sensory processing using event-related potentials and brainstem reflexes. *Psychophysiology, 30,* 415–428.

Holender, D. (1986). Semantic activation without conscious identification in dichotic listening, parafoveal vision, and visual masking: A survey and appraisal. *Behavioral and Brain Sciences, 9,* 1–66.

Lewis, J. L. (1970). Semantic processing of unattended messages using dichotic listening. *Journal of Experimental Psychology, 85,* 225–228.

Loftus, E. F. (1974). On reading the fine print. *Quarterly Journal of Experimental Psychology, 27,* 324.

MacKay, D. (1973). Aspects of a theory of comprehension, memory and attention. *Quarterly Journal of Experimental Psychology, 25,* 22–40.

Moray, N. (1959). Attention in dichotic listening: Affective cues and the influence of instructions. *Quarterly Journal of Experimental Psychology, 11,* 56–60.

Mowbray, G. H. (1964). Perception and retention of verbal information presented during auditory shadowing. *Journal of the Acoustical Society of America, 36,* 1459–1464.

Näätänen, R. (1992). *Attention and brain function.* Hillsdale, NJ: Erlbaum.

Thorndike, E. L., & Lorge, I. (1944). *The teacher's work book of 30,000 words.* New York: Columbia University Teachers College.

Treisman, A. M. (1960). Contextual cues in selective listening. *Quarterly Journal of Experimental Psychology, 12,* 242–248.

Treisman, A. M. (1964). Selective attention in man. *British Medical Bulletin, 20,* 12–16.

Treisman, A. M., & Geffen, G. (1967). Selective attention: Perception or response? *Quarterly Journal of Experimental Psychology, 21,* 1–17.

Treisman, A. M., & Riley, J. G. A. (1969). Is selective attention selective perception or selective response? A further test. *Journal of Experimental Psychology, 79,* 27–34.

Treisman, A. M., Squire, R., & Green, J. (1974). Semantic processing in dichotic listening? A replication. *Memory & Cognition, 2,* 641–646.

Wolford, G., & Morrison, F. (1980). Processing of unattended visual information. *Memory and Cognition, 8,* 521–527.

Yates, J., & Thul, N. (1979). Perceiving surprising words in an unattended auditory channel. *Quarterly Journal of Experimental Psychology, 31,* 281–286.

Received December 16, 1993
Revision received February 28, 1994
Accepted March 10, 1994 ■