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Semantic Processing of Unattended Words in Dichotic Listening - More Evidence for Late Filter Theory.

Marius Szostalo

Algoma University

Abstract

At any given moment the number of concurrent events is too great for conscious analysis. However it is possible to attend selectively to any one event, thereby becoming conscious of its meaning. The question being posed is: to what degree, is the not-attended-to information processed? Early processing theorists (e.g.: Treisman 1964) assumed that the processing of an unattended message took place only when a shift in attention occurs, such as when a threshold is lowered for a particular word. The late processing theories (e.g.: Deutsch & Deutsch 1963) stated that all information is being taken in, and the limitation occurs later in processing. In this study participants were asked to shadow one message while ignoring the other and to react to changes on computer screen at the same time. Participants' reaction time significantly decreased when events on the screen were cued by a word in the ignored message.

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The question of to what degree the unattended-to information is being processed has been around since early fifties. To date there are two main theories.

Early Filter theory.

Early shadowing experiments resulted in findings that the change in unattended message is undetected by most participants (Cherry 1953). These results prompted the development of Broadbent's model. This model assumed the presence of a filter which effectively discriminated against the not-attended-to channel (Broadbent 1958). It proposed, that irrelevant information is not processed beyond its basic features such as pitch, location and intensity (Broadbent 1958).

According to Broadbent's model, semantic changes to the unattended message will not be detected. Just a year later, evidence was found that regardless of the fact that attention was focused elsewhere, participants were able to hear their name in the unattended message (Morray 1959). In 1960, Treisman found that on some occasion participants were not able to avoid following the logical continuation of an unattended story for a few words after the messages were suddenly switched from one ear to another. These findings were inconsistent with Broadbent's theory, and it become clear that some revision was needed.

In 1964 Treisman presented the revised theory, which could explain the new findings. Treisman's theory resembled Broadbent's model closely. The difference is that Treisman's model allows for limited processing of the irrelevant channel. It states that semantic processing of the un-shadowed message can occur only when a threshold is reached and there is a resulting shift of attention. Whether or not the attention shift will occur is dependant on two factors: severity of the change in physical characteristics of the message, and, a preexisting level of activation in memory of the words that are stimulated by the unattended-to channel. This view is supported by findings such as Kidd & Greenwald 1988, who concluded that repetition of a series of numbers in the ignored channel did not lead to recall. Elbert & D'Hollosy 1992, went even further, stating that there is a direct effect of attention on memory. In their study 95% of the subjects did not recall any of the non-attended-to items. This prompted them to develop the following formulas:

STM=A

LTM=A

A=D*T*I

Where STM is short term memory, LTM, long term memory, A, attention, D, direction, T, time and I, intensity. If this reasoning is correct, no unattended information is ever being processed, and recollection of such information is only due to shifts in attention.

Late Filter theory.

Proponents of the late filter theory, assume that all information is being processed regardless of where attention is focused. Any limitation as to what reaches cognitive structures is imposed after initial processing (e.g. Deutsch & Deutsch 1963). According to Late Filter Theory "a message will reach the same perceptual and discriminatory mechanisms whether attention is paid to it or not; and such information is the grouped or segregated by these mechanisms" (Deutsch & Deutsch 1963 p. 3). Deutsch and Deutsch implied that since all the information is processed, there should be at least some memory of unattended information. Later research demonstrated that recall and recognition can occur without attention (e.g. Norman, 1969). Since all the information is being processed, and there exists at least partial memory for the unattended channel (Norman, 1969), the implication is that information from all sources is at least partially available. Working on this assumption Mackay 1973 showed that words presented to the unattended ear can bias the reported meaning of an attended homophone. Furthermore it has been shown that performance on a shadowing task decreased as the complexity of the task increased (Stephens & Pate, 1988). This "filtering cost" was also reported by Kahneman, Treisman and Burkell in 1983. It appears that presenting two stimuli at the same time increases the latency of response to the target stimulus, even when the irrelevant stimulus is not associated with the same class of responses as the relevant one.

Proponents of the early filter theory do not find Mackay's research convincing. It seems that the influence of unattended words on attended ones, is most obvious when the

attended words lead, rather then follow the unattended ones. (Broadbent & Gathercole 1990). This may suggest that semantic processing of unattended words could depend on the priming from words in the attended channel. Also, the filtering cost could be explained in terms of early filter theory. Semantic interference from unattended words decreases with the duration of the shadowing task, suggesting that as participants gain practice, their focus of attention improves (Treisman, Squire & Green 1974). Cross channel interference may result from division of attention, rather the processing of the irrelevant channel. Dawson and Schell (1982) introduced words associated with electric shock into the irrelevant channel, and measured participants' electro dermal responses. They found significant increases in EDR even though participants did not recall hearing target words. This study seems to point towards late filter theory (since participants did not remember hearing the words, yet showed higher EDR, then information was processed but it did not reach the cognitive structures).

These findings are however explained by proponents of early filter theory - words were pre-sensitized so they passed the threshold and were picked up. To further complicate the matter, some theorists argue that in dichotic listening, attention seems to shift subtly to the unattended channel without that attention shifting having been detected by the experimenters (Holender, 1986). This of course could explain all the inconsistencies in the field, but did not prove either point. For since we are always pre-cuing participants to a set of words, which we later weave into the irrelevant channel, we can not be sure that attention did not shift towards the sensitized words (which by

definition will reach the threshold and be attended to) without causing a problem in shadowing. This could mean that shadowing is not a perfect way to detect shifts of attention. It follows that until a better tool is found to assess shifts in attention, the controversy will continue forever, with two opposite theories offering plausible explanation of the same phenomena.

Since a tool better then shadowing is not available, the only viable alternative is to not pre-sensitize any of the words. This way there could not be a shift in attention towards a threshold word, and all information retained from the irrelevant channel is either due to random shifts in attention (congruent with early filter theory) or a constant monitoring of the irrelevant channel with a limitations of what goes into the cognitive structures imposed later (which would suggest late filter theory). Now, since we are not pre-sensitizing any of the words, how would we know what to look for, as far as retention is concerned. We've already established that if early filter theory is correct, the information retained is due to random shifts of attention. Working with this assumption one can conclude that any information retained in that fashion is going to be random, and as far as learning is concerned it would be useless (it could not be referenced well enough to be tied to an event occurring in the focus of attention). If all the information in the irrelevant channel is sampled on an on-going basis, it could be available for cross referencing with events in the focus of attention, which would facilitate learning. If late filter theory, is correct, and sampling of the irrelevant channel is constant, the word in the irrelevant channel will be tied to the event in the focus of attention, and conditioning will

occur. In that case, based on the prime in the irrelevant channel, participants will be able to foresee the onset of the stimulus in the focus of attention. In the event that the early filter theory is right, and sampling of the irrelevant channel is random, the association will not be made, and the latency of response to the stimulus, other then being subject to practice effect, will not change.

Method

Participants

Forty-two students and faculty from Algoma University participated.

Apparatus

Participants were using an IBM compatible computer equipped with a full duplex sound card and headphones. Their shadowing performance was recorded on a tape recorder. For the shadowing task two recordings were used. One consisted of a male voice reading a part of a science fiction story by Kris Neville. The other was a recording of a female voice reading a story written for the purpose of the experiment by Dr. Dominic Grace. Dr. Grace's story had a correct sentence structure, but was devoid of logical sense. Both recordings were digitally corrected for loudness noise levels and timing, then mixed in such fashion that only one was heard in each channel. A computer program able to play the recordings, initiate timed changes of the screen color and record

participant's reaction to those changes was developed and served as the participant - computer interface. Software was developed for purpose of the experiment[1].

Procedure

Participants were tested individually. Participant were asked to sit down, put on the headphones, listen to and repeat the message heard in right ear, while ignoring the left. They were also asked to mind a computer screen. Periodically the screen color changed from white to black, and participant's task was to hit a space bar key on a computer keyboard, immediately following the change. Participants were told that their reaction time is being monitored. For the experimental group the visual event on the computer screen was preceded with the word "president" embedded in the to-be-ignored message. Control group was presented with the same two messages, except that visual event was not tied to any particular word in the messages.

Discussion and results

Despite the fact that word "president" which was a cue for changes on the screen, occurred 34 times in the to-be-ignored message, only three participants were able to recall it. Of these three one claimed to recognize the story from his previous readings and one was a psychology professor familiar with dichotic listening studies, who admitted to expecting a memory test on conclusion of the experiment. Of the other 39 participants,

one (wrongly) recalled words from the attended message others did not notice words which occurred more often then others.

T-test of a log transformed reaction time showed that experimental group did significantly better then control $p = 0.0029$. This could indicate that the cue word was associated with the visual event, despite the fact that it was not remembered. Since the cue word was not pre-sensitized, and there is little chance that association of the cue word with the visual event is due to random shifts in attention. The results of this experiment favor the late filter theory proposed by Deutsch and Deutsch in 1963.

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Footnotes

[1]For a copy of the software contact the programer at mountaindew@ssm.ca or the author.