

IRRELEVANT SPEECH, ATTENTION AND MEMORY IN TEACHERS

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Introduction Irrelevant speech is one of the most annoying noise sources in schools (Lundquist, Holmberg, & Landström, 2000), and this noise source has also showed up to cause detrimental effects on memory performance (Hygge, Boman & Enmarker, 2003). Most studies examining the effects of irrelevant speech and memory concern working memory. The results from these studies show impairment from both meaningful and meaningless speech, particularly on memory tasks with a serial component (Martin, Wogalter & Forlando, 1988; Tremblay, Nicholls, Alford & Jones, 2000). However, meaningful irrelevant speech is more disruptive for reading comprehension and proof reading than irrelevant speech without meaning is (Oswald, Tremblay & Jones, 2000; Martin et al., 1988).

In order to expand the theoretical knowledge Hygge et al., (2003) conducted an experiment with students aged 18-20 years. One of the objectives was to examine the effects of meaningful irrelevant speech on attention and long-term memory compared to a silent control condition. A test battery was adopted in part from a large (N=3000) prospective Swedish study on memory, health and ageing (Nilsson et al., 1997), and from Hygge's et al., own research. The tests were selected to elucidate different memory systems according to Tulving's (1993) theory. The noise effects found were restricted to cued recall of a text in episodic memory, retrieval of word fluency in semantic memory, and speed-to-accuracy trade-off (SATO) effect (Hockey, 1984) in a selective attention task. However, attention did not mediate the effects on memory. The choice of tests was also guided by the plan of future replications on different age groups. The aim of the present study was to further examine the effects of meaningful irrelevant speech on memory and attention in teachers aged 35-45 and 55-65 years, and also to examine whether the noise effects were age-dependent.

Memory research has shown that different memory abilities vary with age and have their performance peaks at different periods in life (Nilsson et al., 1997; Tulving, 1993). Episodic memory, i.e., memories associated with personal events in subjective time, is at its peak around the year of 20 (Tulving, 1993). Semantic memory, the acquisition and use of facts and general knowledge, has its peak at a higher age than 20 years and does not decline as fast as episodic memory with increasing age. However, it has been shown that education is of more importance than age for this memory system (Nilsson et al., 1997). Studies of age differences in memory include a large numbers of studies comparing test on recall and recognition memory. The results show age decrements in recall performances, while the results in recognition memory are mixed (Craik & McDowd, 1987).

Predictions Since episodic memory declines relatively fast with age (Nilsson et al., 1997) it was predicted in the present study that noise would impair free as well as cued recall, and recognition for the verbal episodic memory tasks for the teachers. For recall of sentences with and without a motoric component it was assumed that enactment would give a stronger memory trace compared to the non-enacted encoded sentences (cf. Engelkamp, 1995). It was therefore expected that the degree of impairment would be higher for this latter task. Furthermore, since older persons exhibit decrements in processing resources in divided attention tests compared to younger persons (Allen, Groth, Weber & Madden, 1993) it was also expected that the older subjects, 55-65 years, would be less able than the younger subjects, 35-

45 years, to successfully master all the verbal episodic memory tasks during noise exposure compared to the silent condition.

Since teachers are well-educated and that semantic memory has its peak at a higher age than 20 years and does not decline as fast as episodic memory with increasing age (Nilsson et al., 1997; Tulving, 1993), no predictions about noise decrements were made for the two age groups in this memory system.

Memory is assumed to be intimately related to attention (Styles, 1998). Therefore, a logical argument would be that the search and memory task in attention should show decrements during noise exposure. Accordingly, a SATO-effect (Hockey, 1984) was predicted, i.e., more lines of the task would be completed, while percentage of accurate targets would decrease during exposure to meaningful irrelevant speech. As for the prediction in episodic memory the noise impairment would be worse for the older teachers, 55-65 years, than for the younger teachers (see Allen, et al., 1993). Since memory performance declines when attention is divided (Anderson, Craik & Nahev-Benjamin, 1998) it was also expected that attention would mediate the expected noise effects on memory.

Method

Participants and basic design Sixty-four male and female teachers in the age of 35-45 and 55-65 years were recruited from local upper level regular schools and paid to participate. The participants were randomly assigned to each: a) meaningful irrelevant speech, and (b) silence. Each group consisted of 32 participants with equal numbers of subjects ($\underline{n}=16$) and genders (females $\underline{n}=10$ and males $\underline{n}=6$) from each age groups.

Procedure The experiment was run in a climate chamber (4 x 6 m) with controlled air temperature (21°C) and light level (900 lx). Three to four subjects stayed in the experimental room at the same time, but worked on the tasks individually. They were seated in a row at a table and in front of the subjects there was a computer screen. All sessions were run in the afternoon. At the outset, the subjects were informed that the study was about memory. They were told that they would be given separate instructions and time limits ahead of each task (see Table 1). The only difference between the groups was the different conditions during first part of the experiment. Altogether, the experimental session lasted for approximately two hours and the noise exposure for 50 minutes.

Noise In the noise conditions digital recording of meaningful irrelevant speech was played back through loudspeakers in front of the room. The equivalent sound level in the noise conditions was set to 66 dBA 2 m in front of the loudspeakers. The sound level in the silent control group was 38 dBA L_{eq} . The meaningful irrelevant speech recording consisted of background babble (~62 dBA) without any discernible meaning. Segments from a conversation between two teenagers, only one person talking at a time, were superimposed on the babble background. The peaks (fast) in the superimposed segments were at 78 dBA and occurred on the average once per minute and with different duration. The dominant frequency range for the meaningful irrelevant speech was 500-1500 Hz.

Dependent measurements The dependent measurements were the same as in Hygge et al., (2003). The order of the tasks and time limits are given in Table 1.

Table 1 Chronological Order of Dependent Measures and Time Limits for Each Task

| Test No. | Dependent measure | Block | Time min. |
|----------------|--|----------------|------------|
| 1) | Self-reported affect and activation | Block 1 | 5 |
| Part 1 | <i>Encoding and retrieval in silence or meaningful irrelevant speech¹</i> | | |
| 2) | Attention, search and memory task (SMT) | Block 1 | 6 |
| 3) | Reading a text | | 15 |
| 4) | Face and name encoding | | 2.5 |
| 5) | Word fluency | | 3 |
| 6) | Word comprehension | | 7 |
| 7) | Encoding of sentences with and without enactment | | 4.5 |
| 8) | Attention, search and memory task (SMT) | Block 2 | 6 |
| Part 2 | <i>Retrieval in silence</i> | | |
| 9) | Self-reported affect and activation | Block 2 | 5 |
| 10, 11) | Test of free and cued recall of sentences in task 7 | | 10 |
| 12) | Recognition test of faces and first and family names | | 12 |
| 13) | Test of cued recall of sentences in task 7 | | 4.5 |
| 14) | Test of recall and recognition of text in task 3 | | 10 |

Note. Only the bold typed dependent measures are reported in this article.¹ The actual experiment also included a third condition, road traffic noise, which is not reported here.

Cued recall and recognition of a text in episodic memory The first episodic memory task consisted of reading a text about a fictitious ancient culture for 15 min. In order to prevent the readers from using their possible knowledge about the culture, imaginary words and names replaced real ones. In about one-hour later text comprehension was tested with eight cued recall and twelve multiple-choice recognition questions in silence (see Table 1, task 14).

Sentences with and without enactment in episodic memory. In this test (Nilsson et al., 1997) the participants were presented with two successive lists in imperative form with 16 sentences each. For one of the lists the encoding was done with enactment (making the movements but imagining the object) and for the other list without enactment. The lists were counterbalanced. Each sentence was presented on the computer-screen for 8 s. Around 15 min later there was a free recall test in silence (see Table 1, task 10). Immediately after that a cued recall test with category names were presented (task 11), the task was to recall nouns from the sentences. After another 12 min a phrase containing the verb from the earlier presentation was presented on the screen. The task was to fill in the missing noun in the phrase (see Table 1, task 13). These tests made it possible to study noise effects on episodic memory with and without involvement of a motoric component.

Word fluency in semantic memory. The word fluency test consisted of three sets of words to be generated, each set starting with a certain letter (Task 5 in Table 1). The sets were: words, five-letter words and professions (Nilsson et al., 1997). Each set was given one minute.

Word comprehension in semantic memory. In the second semantic memory task (Nilsson et al., 1997) the subjects were presented with a list of 30 target words (see Table 1 task 6). Next to each target five other words were presented, one of which being synonymous to the target word.

Search and memory task (SMT) - attention. In this selective attention task (Smith & Miles, 1987), subjects were presented lines of random letters with five target letters at the beginning of each line. The task was to memorise the given targets, search through the given line only once, and to mark all targets found. Each line contained 59 letters, 0-4 of which were targets. Lines were arranged in sets of six, with 11-14 targets distributed through each set. The task was scored both for percentage of targets missed (accuracy) and number of letters completed (speed). The SMT was performed in the beginning of the experiment and as the last task before the silent period (see Table 1). By administrating the task twice, both initial and accumulated noise effects on attention could be assessed.

Self-reported affect At the beginning of the experiment, before any noise exposure, and at the beginning of the silent period the subjects filled in a self-reported affect measure (Knez & Hygge, 2001). In this way high and low activation (arousal) was measured.

Result

Cued recall and recognition of the text in episodic memory The outcome on the cued recall of the text read earlier in the experiment as a function of noise conditions during encoding and ages showed a significant effect of Noise, $F(1,60) = 28.90$, $MSE = 6.31$ $p = .000$ (see Figure 1). Thus, noise impaired cued recall of the text in episodic memory in the predicted manner. However, there was no interaction between Noise and Age.

Also in congruent with prediction there was a significant effect of Noise on the recognition items, $F(1,60) = 9.25$, $MSE = 3.57$, $p = .003$ (see Figure 2). As for cued recall, no interaction between Noise and Age occurred.

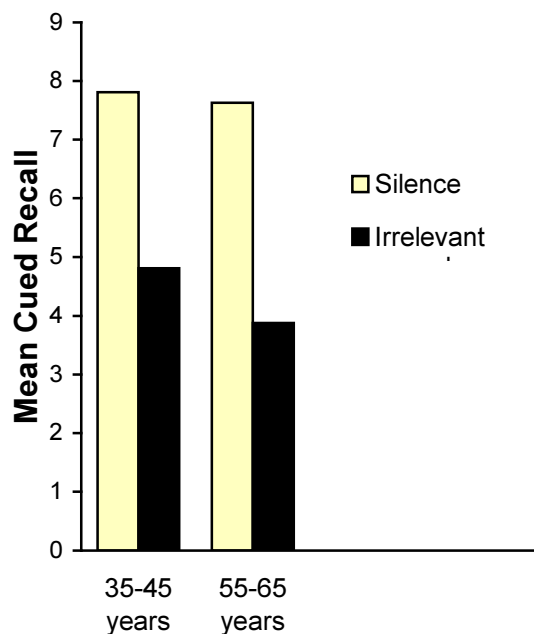


Figure 1 Mean scores on the cued recall items of a text in episodic memory

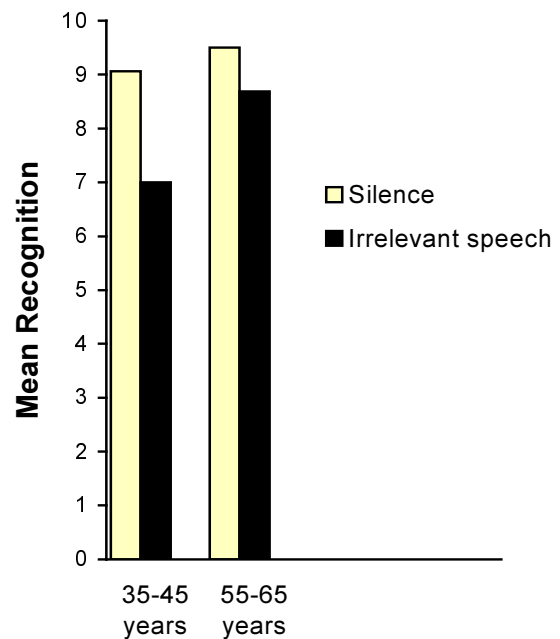


Figure 2 Mean scores on the recognition items of a text in episodic memory

Recall of sentences with and without enactment in episodic memory The multivariate analyses showed a tendency of significant Noise effects for the recall of sentences with and without enactment, Wilks' $\lambda = .810$, $F(6,55) = 2.15$, $p = .062$, indicating that more nouns from the sentences encoded with enactment as well as without enactment were produced in silence compared to the meaningful irrelevant speech condition when category names were presented, $F(1,60) = 6.54$, $p = .013$, respectively $F(1,60) = 4.76$, $p = .033$. The expected difference between the degree of impairment for the with and without enactment sentences did not show up ($F < 1$). Neither did the interaction between Noise and Age.

Word fluency in semantic memory In contrast to expectations there was an overall effect of Noise on the three word fluency test in semantic memory, Wilks' $\lambda = .786$, $F(4,57) = 3.88$, $p = .007$. The analyses revealed that more words on a certain letter were produced in the silent condition compared to the meaningful irrelevant speech condition $F(1,60) = 9.29$, $p = .003$ (see Figure 3). There was no overall interaction between Noise and Age.

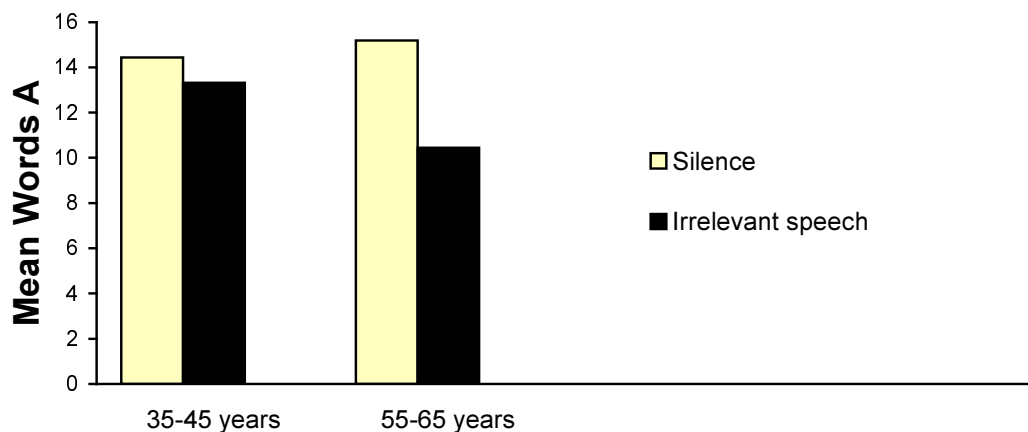


Figure 3 Mean scores on the word fluency task generating words in semantic

Attention The predicted speed-to-accuracy trade-off was not supported ($F < 2.19$). Neither, was the interaction Noise x Age ($F < .60$). Since there was no effect of noise on attention the predicted mediating effect of attention on memory was ruled out.

Self-reported affect The self-reported affect dimensions did not differ between the groups. Therefore, arousal was also ruled out as a mediator for the noise effects.

Discussion As in Hygge et al., (2003) the result in the present study showed noise impairments in both episodic and semantic memory. However, the expected age-dependent noise effects did not occur. Nor was there any SATO effect.

The decrements in episodic memory during meaningful irrelevant speech could be explained by the competing semantic nature content, which interferes with the verbal material and increases the cognitive burden while encoding. These results are congruent with research on meaningful irrelevant speech effects on reading comprehension and proof reading (Martin et al., 1988; Oswald et al., 2000). However, contrary to expectation retrieval from semantic memory was impaired, which also could be explained by the semantic content in the speech.

In contrast to Hygge et al., (2003), the SATO hypothesis did not receive any support in this study. The lack of noise effects on attention is somewhat incompatible with the assumption that memory performance declines when attention is divided at the time of encoding relative to conditions of full attention (Anderson, et al., 1998).

To sum up, the result from this study again replicated that cued recall of a meaningful text, which demands comprehension, is vulnerable to exposure to meaningful irrelevant speech. The results also showed that attention and arousal did not mediate the noise effects. Thus, it can be assumed that there is some kind of direct connection between meaningful irrelevant speech and the affected memory tasks in the episodic and semantic memory systems for adults.

Keywords: Noise, Meaningful irrelevant speech, Episodic memory, Semantic memory, Attention, Adults

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