THE RELATIVE IMPACT ON RECALL OF ROAD-TRAFFIC NOISE DURING ENCODING AND REHEARSAL OF A TEXT

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Hygge, Staffan
University of Gävle, Department of Built Environment
SE-801 76
Gävle
Sweden
Tel: +46 26 64 81 53
Fax: +46 26 84 81 81
E-mail: Staffan.Hygge@hig.se

ABSTRACT

In a 2x2 - experiment noise/no noise was varied while reading (encoding) and memorizing (rehearsal) a text. From earlier studies with the same text and the same noise (fluctuating road traffic noise) it was expected that noise while encoding would impair recall of the text. It was also expected that noise during rehearsal would impair recall, but to a smaller extent than during encoding. Measures of emotional affect and short-term memory were taken to find out any mediating effects on recall.

At the time of writing this abstract, the results are not analyzed, but will be presented at the conference.

INTRODUCTION

In earlier experiments on children and adults [1, 2], acute noise during the encoding phase has been shown to reliably impair long-term recall, but not recognition of a text. In a field study of children around the new and old airports of Munich [3, 4, 5], chronic noise was shown to also impair long-term recall of a text. In the latter case there was no difference in noise during the encoding of the text between the chronically aircraft noise group and the group that was not chronically

exposed, and thus noise at encoding can not be used as an explanation for the effect of chronic noise.

A simple hypothesis, which could reconcile the effects of chronic and acute noise on the recall of a text, is to assume than there are effects on the recall of the text both from noise during encoding and from noise during an ensuing rehearsal phase after the encoding, but before the test for recall. If no effects can be shown from the rehearsal phase on the recall, in seems likely that chronic noise in real life situations mainly has its effect on recall by means of chronic impairment of encoding processes, an impairment that is in effect before the encoding of the text started.

In order to test this idea, a 2 x 2 factorial experiment was designed, where noise during encoding and subsequent rehearsal of a text was manipulated. See Table 1 for a layout of the experiment.

The main predictions were that if chronic noise exposure has a reliable effect on the recall of the text, and that effect builds up during the rehearsal period, there would be significantly less recall in Group 2 than in Group 1. A difference between Groups 3 and 4, to the advantage of Group 3, is expected to the extent that encoding and rehearsal are independent of each other.

Table 1: Layout of the 2 x 2 experiment.

	Rehearsal 15 min	
Encoding 15 min	No noise	Noise
No noise	Group 1	Group 2
Noise	Group 3	Group 4

METHOD

Participants and basic design

Ninety-six male and female students, aged from 17 to 19, were recruited from a local high school and paid to participate. Equal numbers of males and females were randomly assigned to each of the four independent groups. In all groups there was 15 min for encoding the text, immediately followed by 15 min of rehearsal. At the beginning and in the middle of this rehearsal period participants were given a set of keywords (e.g. rivers, seas, towns, trade, farming, art, architecture, religion, written language, science, culture, civilization, the fall of the culture) around which to organize and memorize the information in the text.

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. Altogether, the experimental session lasted for a little more than two hours. See Table 2 for order of tasks and time limits.

Noise

In the noise conditions recordings of road traffic noise were 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 conditions were 38 dBA Leq. The road traffic noise recording was made up of a background of continuous traffic noise (~62 dBA) with superimposed segments of trucks passing by. 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 road traffic noise was 100-300 Hz. This was the same road traffic noise as in one of the conditions in [1].

Dependent measures

The presentation order and duration of each of task is shown in Table 2.

Table 2: Presentation order of tasks and allotted time.

Task	Time min.
Circumplex 1	5
Familiarization SMT	4
SMT 1	6
Text reading - Noise/No noise	15
Rehearsal, instructed - Noise/No noise	15
SMT 2	6
Embedded figures	25
Circumplex 2	5
Word fluency 1	2
Word fluency 2	2
Word comprehension	6
Word fluency 3	2
Baddeley, negations only	15
Test cued recall and recognition of text	10
SMT 3 - Noise for all	6

Cued recall and recognition of a text. This episodic memory task consisted of reading a text about a fictitious ancient culture for 15 min. The subjects replied in writing to four recall questions and six multiple-choice questions, respectively around 80 min later. When presented with the text the participants were informed that they would later be asked questions about the text.

Search and memory task (SMT). In this attention task [6] subjects were presented with lines of random letters with five target letters at the beginning of each line. The task was to memorize 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 accuracy (percentage of targets missed) and speed (number of lines completed). In the SMT there is not much of a learning effect [6]. This task was performed in silence before encoding and after rehearsal to find out any after-effects of noise exposure. This task was also performed in noise for all participants to evaluate whether differential attention capacities mediated noise effects on recall.

Word fluency and word comprehension. In the word fluency tests, three sets of words were to be generated, each set starting with a letter of its own. The sets were: words starting with the letter A, five-letter words starting with M, and name for professions starting with B [7]. In the word comprehension task [7], the subjects were presented with a list of 30 target words. Next to each target five other words were presented, one of which being synonymous to the target word. These word tasks were intended to assess semantic memory and whether semantic memory mediated noise effects on recall.

Self-reported affect and activation. At the beginning of the experiment and after the rehearsal period the subjects filled in a self-reported affect measure [8]. Perceived affect and activation were rated on Likert-scales in five steps. In all there were 48 items organized into 8 unipolar scales, tapping combinations of high and low activation, pleasantness and unpleasantness. This task was both a time-filler and intended to see whether lasting affect states mediated noise effects on recall.

Baddeley's logical reasoning task and embedded figures. These tasks were taken over in modified form from [9, 10] and were given both to keep the same delay as in [1] between reading the text and being tested for recall and recognition, and to see whether they mediated noise effects on recall.

EXPECTED RESULTS

Since the data collection for the study has been delayed, results are not available at the time of writing this paper. However, by the time of the InterNoise 2002 Congress the main results are expected to be at hand.

The expected main results concern the effects of noise during encoding and/or rehearsal on the subsequent recall of the text. To exemplify the pattern of expected results, see Figure 1, where the dashed line for rehearsal in silence depicts what actually happened in the corresponding road-traffic noise group in [1]. Since the present study in several respects is a replication of [1], including reading the same text, the students being in the same age range, using the same noise, and the same time restraints, the results in the present study are expected to be close to the dotted line in Figure 1.

For rehearsal in noise, when encoding is done in silence, a significant noise effect is expected. That is, in the left panel of Figure 1, in the silent encoding condition, there should be less recall while rehearsing in noise than rehearsing in silence. For the right hand panel of Figure 1, the prediction is less certain. Although it is expected that rehearsal in noise would yield less recall than rehearsal in silence when the encoding is done in noise, there is no founded reason to believe that this difference between rehearsal conditions should be of the same magnitude as the difference when rehearsing in silence.

In line with the results from [1] no noise effects are expected on recognition. Also in line with the results from [1] no significant noise effects or mediating effects on recall are expected on affect and activation. For the SMT task it is expected is expected that performing the task in noise (SMT3) would increase speed and impair accuracy.

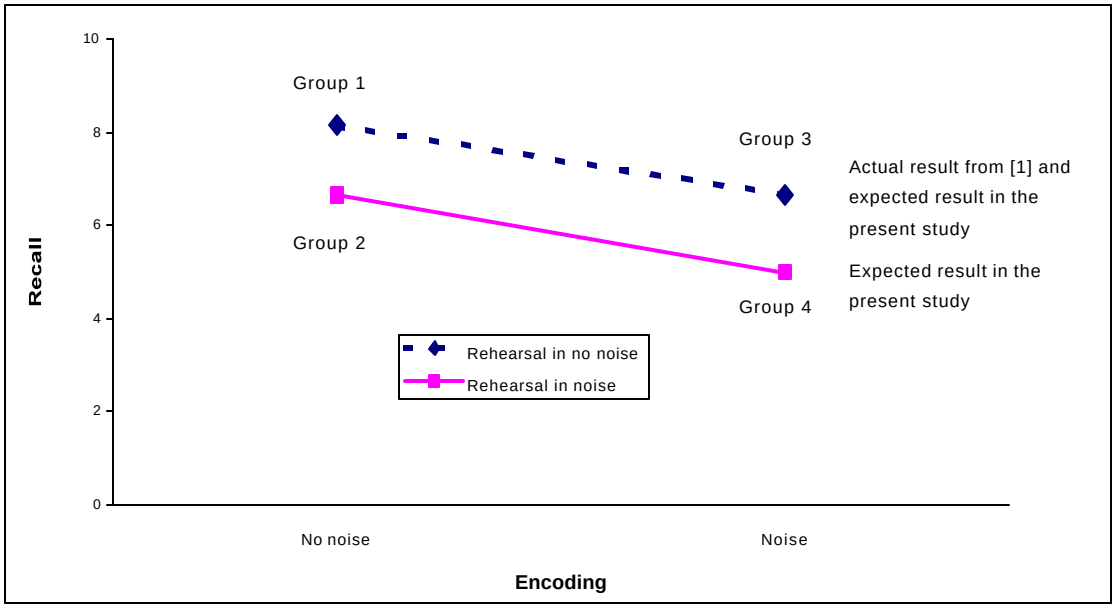

Figure 1: Expected results in the present study.

EXPECTED CONCLUSIONS

If there is reliably less recall in rehearsal in noise (Group 2) than in rehearsal in no noise (Group 1) in the no noise encoding group (left panel in Figure 1), there is support for the idea that chronic noise impacts recall by impairing rehearsal after the encoding. If, in the noise encoding group (right panel in Figure 1), there is reliably less recall in rehearsal in noise (Group 4) than in rehearsal in no noise (Group 3), there is support for the idea that noise during encoding and rehearsal have additive effects on the recall of the text.

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REFERENCES

1. S. Hygge, E. Boman and I. Enmarker. The effects of road traffic noise and meaningful irrelevant speech on different memory systems. *Scandinavian Journal of Psychology*, in press.
2. S. Hygge. The effects of different noise sources and noise levels on long-term memory in children aged 12-14 years. In A. Schick and M. Klatte (Eds.), *Contributions to psychological acoustics. Results of the seventh Oldenburg symposium on psychological acoustics* (pp. 483-501). Oldenburg, Germany: Bibliotheks- und Informationssystem der Universität Oldenburg, 1997.
3. G.W. Evans, S. Hygge and M. Bullinger. Chronic noise and psychological stress. *Psychological Science* **6**, 333-338, 1995
4. G.W. Evans, M. Bullinger and S. Hygge. Chronic noise exposure and physiological response: A prospective study of children living under environmental stress. *Psychological Science* **9**, 75-77, 1998.
5. S. Hygge, G.W. Evans and M. Bullinger. A prospective study of some effects of aircraft noise on cognitive performance in school children. *Psychological Science*, in press.
6. A.P. Smith and C. Miles. The combined effects of occupational health hazards: an experimental investigation of the effects of noise, nightwork, and meals. *International Archives of Occupational and Environmental Health* **59**, 83-89, 1987.
7. L.G. Nilsson, L. Bäckman, K. Erngrund, L. Nyberg, R. Adolfsson, G. Bucht, S. Karlsson, M. Widing and B. Winblad. The Betula prospective cohort study: Memory, health, and aging. *Aging, Neuropsychology, and Cognition* **4**, 1-31, 1997.
8. I. Knez and S. Hygge. The circumplex structure of affect: A Swedish version. *Scandinavian Journal of Psychology* **42**, 389-398, 2001.
9. A.D. Baddeley. A 3 minute reasoning test based on grammatical transformation. *Psychonomic Science* **10**, 341-342, 1968.
10. Smith and D.E. Broadbent. Effects of noise on performance on embedded figures tasks. *Journal of Applied Psychology* **65**, 246-248, 1980.