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The Interaction between Working Memory Capacity and Noise on Recall and Recognition of Orally Presented Text

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Abstract

The objectives of the present study were 1) to examine the effects of noise exposure on recall and recognition of orally presented text and 2) to examine the relation between working memory capacity and the performance of recall and recognition of orally presented text in noisy conditions. A total of 32 subjects, age 20-33, with no known hearing impairment, were paid to participate in the experiment. The hearing ability of all subjects was tested using recorded sentences with and without background noise. Their working memory capacity was tested using listening span, reading span and operation span tests measuring a) correctly recalled words of all three tests, b) the response latency in the reading span test and c) the processing time of the arithmetical operations in the operation span test. Finally all subjects took recall and recognition tests on texts presented orally with and without broadband background noise (white noise). The test results showed that 1) noise had no significant main effect on recall or recognition of the spoken texts, 2)) the capacity of the central executive component of working memory, measured as the processing time of the arithmetical operations of the operation span test, correlated significantly with recall and recognition of the orally presented text in the noise condition, but not in the control condition, 3) noise exposure had a negative effect on the recognition performance of subjects with lower capacity of the central executive component of working memory.

Keywords: Noise, speech, working memory capacity, working memory span tests, recall, recognition

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1 Introduction

1.1 Acoustic conditions and speech

In school, but also in most other work places, a good quality of speech communication is of fundamental importance for the work result. It is essential to hear, understand and remember what other people say. Several factors in the acoustic environment can disturb communication and learning.

The most important acoustic prerequisites for good speech communication are a proper signal/noise ratio and a proper reverberation time. The signal/noise ratio (S/N ratio) stands for the difference in sound level (dB) between the speech signal and the background noise. The reverberation time is defined as the time it takes for the sound to decrease 60 dB below its level after it has been turned off.

The effects of acoustic conditions on hearing single spoken words and sentences have been considered in many studies. The results of these studies have become the basis of acoustic norms for classrooms and other premises where proper speech communication is essential for the work result. There are reasons though to assume that the requirements in these norms have not been severe enough. Bad acoustic conditions probably may disturb processing and storage of the spoken information as a whole even when the acoustic conditions are good enough to make it possible to identify the single words. Relatively few studies have considered these cognitive consequences of bad acoustic conditions (Kjellberg, 2004).

Many studies though, have considered the effects of noise on memory performance (e.g. Boman, Enmarker & Hygge, 2005) where the material to be remembered has been a written text. Spoken material has been avoided, since an impaired memory performance in a noisy environment could be explained by noise making it impossible to hear parts of what is said.

Bad acoustic conditions can complicate the processing and storage of spoken information, as shown by Kjellberg, Ljung & Hallman (2007). In this study subjects should recall as many words as possible from two orally presented wordlists. One wordlist was presented with background noise giving a S/N ratio of +4 dB and the other without this background noise. The subjects were told to repeat each word loudly and clearly, to remove any doubts that they had heard the words correctly. After listening to each list they were asked to write down all words they could recall. The performance of this recall test was significantly worse in the noise condition than in the control condition. The noise effect tended to be larger the less capacity of the working memory the subject had. The recall test in this study was however of a type that is seldom met outside of the laboratory. No effect of noise exposure on recognition performance was found in the study by Kjellberg, Ljung & Hallman (2007).

A previous study by Green (2007) tested the noise effect in a situation that is more like the one you meet in school and at work: each subject listened to two narrative texts, one in a noise condition with recorded broadband background noise (white noise) and one in a control condition without the recorded noise. Directly after listening to each text there was a paper-and-pencil test of recall and recognition of the spoken text information. The performance of the recall test was significantly better in the control condition than in the noise condition.

The present study was built upon the previous study by Green (2007) but was improved in several aspects as a result of the experiences made in that study, which showed some weaknesses:

- The hearing test didn't work as expected. The subjects made many listening errors, probably due to the test sentences being odd and having no redundancy. Thereby the test probably underestimated the possibility to hear the texts in noise. These errors could probably have been avoided if the subjects had got some training prior to the test.
- There was only a reading span test to measure the capacity of the working memory. This might not have been enough to get a reliable and valid measure. Furthermore, the reading span test used did not allow the measurement of response times, which may be a more valid measure of working memory capacity than the number of correctly recalled words.
- Many of the subjects had some previous knowledge about one of the test texts. This was difficult to avoid as there were only three texts to select from.
- The number of multiple choice questions used to measure overall comprehension was too small and these questions had very low reliability.

The present study used broadband background noise, as in the previous study. Larsby, Hällgren, Lyxell & Arlinger (2005) studied three different types of background noise: 1) ICRA noise, artificial randomised noise with speech like characteristics, 2) Hagerman noise, computer generated noise from a digital randomised sample of sentences read by a female speaker, 3) Speech in the form of reading a story, and 4) No noise. The subjects performed different kind of cognitive tasks like matching and decision making, but no task included listening to narrative texts like in the present study. Larsby et al. found that there were differences between the different types of background noise. Noise with temporal variations but without meaningful content was most disturbing. In the present study broadband noise was used, with a steady noise level of 59 dB, which should consequently have a less disturbing effect than noise with temporal variations.

1.2 Working memory

Within cognitive psychology, the concept of working memory (WM) represents a modification and extension of an earlier concept, short-term memory, which is a temporary memory store. The concept of WM differs from that of short-term memory in two respects: 1) it is assumed to involve a

number of subsystems, rather than a unitary module; and 2) there is considerable emphasis on its functional role in other cognitive tasks such as learning, reasoning, and comprehension.

Most theorists postulate multiple subsystems within WM, or some other mechanisms that are domain specific in nature. Many models define WM as temporary maintenance of task-relevant information in the service of complex cognition. The model with most empirical support still seems to be that of Baddeley (Miyake & Shah, 1999).

Baddeley's (2002) multi-component model of WM consists of the following components: 1) *The central executive* – which performs logical operations and controls and regulates the other components of WM, as well as accessing information from long term memory, 2) *The phonological loop* - which is a maintenance mechanism (rehearsal) and a temporary store for verbal information, 3) *The visuo-spatial sketchpad* – which is active in perception and processing of visuo-spatial stimuli, and 4) *The episodic buffer* – which holds and processes episodic information and also integrates information from the phonological loop, the visuo-spatial sketchpad and long term memory. The most crucial component of WM is the central executive as it regulates the other components.

The different components of working memory are responsible for processing and temporary storage of information when we listen to a text. The capacity of WM is limited (Baddeley, 2002).

Initially the central executive seemed to be a convenient homunculus, a little man who took the important decisions as to how the two slave systems should be used (Baddeley, 2002). Recent research has, however, found that a number of executive functions and capacities can be distinguished. These are involved both in storage and a number of more general cognitive processes. Executive processes seem to be involved whenever information needs to be manipulated. Simple representation and maintenance on the other hand may be independent of the central executive. In complex cognitive abilities the central executive seems to be involved mostly as a source of attention control enabling the focusing of attention and the division of attention between concurrent tasks. (Repovs & Baddeley, 2006)

Executive attention is a critical aspect that has been defined as the ability to maintain memory representations in a highly active state despite interference. It is critical because plans, goals, and tasks are more easily retrieved from long-term memory when no interference is present. Individual differences in this capability are labelled as working memory capacity. The active maintenance of information and the ability to block distractors are highly interdependent features of executive attention that form the basis of working memory capacity. (Coolidge & Wynn, 2005)

Noise can undoubtedly be regarded as a distractor, and performance in noisy conditions should thereby be dependent on the working memory capacity.

1.3 Testing working memory capacity

Apart from intelligence tests, working memory span tasks, such as the counting span, operation span, and reading span tasks, are among the most widely used measurement tools in cognitive psychology. They have been administered to literally thousands of subjects in over a hundred independent studies and have proven to be both reliable and valid measures of working memory capacity. Performance on these tasks depends on several factors, like chunking, rehearsal, storage, cognitive control and executive attention. The WM span tasks predict complex cognitive behaviour such as reading comprehension, problem solving, and reasoning, primarily because of the general, executive attention demands of the tasks. (Conway et al, 2005)

In the reading span test the subjects have to judge whether sentences are either semantically or syntactically correct, and simultaneously they have to remember the last word of every sentence for later recall. The sentences are presented visually in sets of sentences (usually two to five sentences per set). After each set the subjects are asked to recall the last word of each sentence previously presented. The reading span performance is mainly dependent on the phonological loop component of WM for storing and rehearsal of the words, but also on its central executive component for the parallel processing and attention demands.

The listening span test is usually administered in the same way as the reading span test except from the sentences being presented auditorially. In the present study this method was modified and combined with hearing tests.

In the operation span test the stimuli consist of simple arithmetical operations (like: "Is (6/3) +1 = 4?"), followed by a to-be-remembered word. The subjects have to judge if the suggested operation results are correct or incorrect. The calculations are done silently without the aid of pencil and paper. The operations are presented visually in sets of operations (usually two to five operations per set). The subjects are asked to recall the visually presented words after each set. Like the reading span test, performance of the operation span test is dependent on parallel processing, rehearsal, storage and attention demands, but this test requires more resources from the central executive component of WM due to the logical processing of the arithmetical operations.

According to De Rammalaere, Stuyven & Vandierendonck (2001) executive processes are crucial in arithmetic. The results in their study suggest that the central executive has a general effect on processing arithmetic tasks. The processing time of the arithmetical operations of the operation span test should consequently be a valid measure of the capacity of the central executive component of WM.

The counting span test has frequently been used to measure WM capacity in school-aged children. The counting span task involves counting shapes, like dots, and remembering the count total for later recall. (Conway et al, 2005)

The reading span, operation span, and counting span tasks share an underlying structure and are implemented in much the same way; they are all designed to engage executive attention processes. A critical feature of the processing component of WM span tasks is that it interferes with rehearsal. (Conway et al, 2005)

Friedman & Miyake (2005) compared four scoring methods for the reading span test and found that all four methods were highly correlated. The scoring method *Total words* (the total number of words recalled across all trials) got the highest Cronbach's Alpha values and showed the best correlation between test-retest. The method *Proportion words* (the average proportional recall for each trial) was the second best method with almost as good results as *Total words*. The other two methods examined in their study were *Correct set words* (the total number of words recalled in perfectly recalled sets) and *Truncated span* (the highest level at which the participant recalled a majority of sets). Friedman & Miyake recommend use of the *Total words* or *Proportion words* scoring methods. In the present study the *Total words* method was used.

1.4 Acoustic conditions, working memory capacity and speech comprehension

When the content of the message is in correspondence with the context, and when the speech signal is clearly audible, speech understanding does not require any effort for young and normal hearing individuals. When listening conditions are not so good, speech understanding can still be good, if the semantic context and the linguistic structure offer redundancy. When speech signal gets less audible and one has to rely more on redundancy and top-down processes, speech understanding changes from being effortless to become straining. The more resources that are used for word recognition, the fewer are left for parallel processing and storage of information. Speech understanding in bad signal/noise conditions therefore requires more of the limited resources of the working memory, than speech understanding in good acoustical conditions does (Kjellberg, 2004).

The strain on working memory is assumed to be greater for people with less working memory capacity. Pichora-Fuller, Schneider & Daneman (1995) compared two groups of adults in a working memory task, and found that older subjects recalled fewer of the items they had perceived than young subjects in noisy conditions, even though there was no difference in the recall ability of the two age groups when sentences were read. Furthermore the number of items recalled by both age groups was reduced in noisy conditions. They concluded that reallocatable processing resources are used to support auditory processing when listening becomes difficult - either because of noise, or because of age-related deterioration in the auditory system. Because of this reallocation, these resources are unavailable to more central cognitive processes such as the storage and retrieval functions of working memory.

Elderly listeners often experience considerable difficulty understanding speech in noisy listening conditions. Reverberation, competing signals and noise are often present in everyday

situations, so it is not surprising that elderly find it difficult to understand speech in everyday life. Such difficulties in understanding speech by the elderly could result from age-related changes in auditory processing or in deterioration in the cognitive processing of speech, or both. (Pichora-Fuller, Schneider & Daneman, 1995)

In line with the discussion above, Kjellberg, Ljung & Hallman (2007) found that there was a significant association between working memory capacity and the effects of noise on free recall of a word list.

1.5 Purpose

The objectives of the present study were 1) to examine the effects of noise exposure on recall and recognition of spoken narrative text and 2) to examine the relation between working memory capacity and the effects of noise exposure on recall and recognition of spoken text information. This study had the same purpose as, and was build upon, the previous study by Green (2007), with the difference that the method in the present study was improved in several aspects as a result of the experiences made from the previous study:

- The hearing test was expanded and included training sessions with and without background noise, and included also a listening span test: the subjects were asked to recall the last word in every sentence after each set of sentences.
- Apart from the listening span test the working memory testing was expanded to include an operation span test as well as an improved reading span test. Response times were measured in the reading and operation span tests.
- The texts were more carefully selected to prevent the subjects from having prior knowledge about the contents.

1.6 Hypotheses

- From previous studies (Rabbit, 1966; Green, 2007; Kjellberg, Ljung & Hallman, 2007) a deteriorated recall of information in the text was predicted in the broadband background noise condition, as compared with the control condition.
- From previous studies (Kjellberg, Ljung & Hallman, 2007) less deterioration in noise was expected for recognition of information in the text.
- The effect of noise was assumed to be less in subjects having greater working memory capacity.

2 Method

Initially each subject's hearing ability and working memory capacity was tested, after which their recognition and recall of orally presented text was tested. The subjects listened to one text *with* recorded white background noise (Noise condition), and another text *without* recorded background noise (Control condition).

2.1 Design

The study had a within subject experimental design, with two conditions of the independent variable, a condition with broadband background noise having a signal/noise ratio of 64/59 dB (A), and a control condition without the broadband background noise with a signal/noise ratio of 64/35 dB (A). Unfortunately problems were found with one of the texts, therefore the test results for this text were excluded and the study got a between subjects design for the other text.

2.2 Participants

The subjects were recruited by convenience. 32 university students, age 20-33, were paid to participate in the experiment. This age group was chosen with the purpose of getting less variation of the capacity of the subjects' working memory and hearing, which both deteriorate with increasing age.

2.3 Data collection

2.3.1 Material and apparatus

The spoken texts were recorded on a CD. The texts were taken from two reading comprehension tests previously used in the Swedish University Test (Högskoleprovet). The CDs were played on a Numark CD player with mixing functionality for two CDs, as well as separate adjustable output levels. The sound levels were measured with a Bruël & Kjaer sound level meter. Two loudspeakers were placed in the room, one on each side about 1.5 meters in front of the table where the subject was seated. The loudspeakers were connected to an amplifier so that the speech signal and the broadband noise could be separated and controlled manually. The working memory tests were performed on a laptop computer. The other tests were paper and pencil tests.

2.3.2 Noise

In the noise condition, broadband noise was presented simultaneously with the spoken text. The signal/noise ratio was +5 dB. This S/N ratio is considered being trying, but large enough to make it possible to hear all the text. The equivalent A-weighted sound level of the noise in the noise condition was 59 dB (A). In the control condition, the level of the background noise was 35 dB (A) and the sound level of the recorded speech was the same as in the noise condition, i.e. 64 dB (A).

2.3.3 Memory and hearing tests

Hearing test. The hearing test consisted of lists of sentences presented with and without recorded broadband noise, see Appendices 3.1 – 3.4. The sentences were presented in four rounds:

1) Training round of ten Hagerman sentences presented *without* recorded noise
2) Training round of ten Hagerman sentences presented *with* recorded broadband noise
3) Test round of ten Hagerman sentences and ten "normal" sentences presented *without* recorded noise. This round was combined with the listening span test.
4) Test round of ten Hagerman sentences and ten "normal" sentences presented *with* recorded broadband noise

The sentences were recorded on a CD. All Hagerman sentences had the same structure (e.g. *Sean took eighteen old balls, Anna held three beautiful rings*), and they had no redundancy; i.e. they had no context so you could guess what word would follow. The other sentences were of normal character with a normal context (e.g. *The oranges are from southern Spain, The birch trees are yellow in mid September*). The subjects were asked to immediately repeat each sentence aloud. Words that were incorrectly repeated were registered in all rounds, but only the results from the real test rounds were used to measure the hearing ability. For the listening span test the subjects were asked to recall the last word in every sentence after each set of ten sentences. The Hagerman sentences were taken from standardised hearing tests revised by Karolinska Institutet, Teknisk Audiologi (Hagerman, 1982).

Working memory span tests. There were three working memory span tests:

1. *Listening Span.* The subjects were asked to recall the last word in every sentence after each set of sentences. There were two sets of ten sentences for the listening span test, ten Hagerman sentences and ten sentences of normal character, see Appendix 3.3. The scoring method *Total words* was used to measure the working memory capacity.
2. *Reading Span.* A test of working memory capacity consisting of 25 sentences being displayed on the computer screen in groups of three to seven sentences. The subjects had to judge if the sentence content made sense or not. Half of the sentences were absurd (e.g. The house was tired) and half of them were normal (e.g. The priest read the Bible), see Appendix 1.1. After three to seven sentences the subjects got the instruction to recall and repeat loudly the last word in each sentence previously displayed on the screen. There were two training sentences as a start. Three measures were registered during the reading span test: 1) the number of correctly recalled words, 2) the number of incorrectly made judgements regarding sentence content, 3) the response latency.

3. *Operation Span.* Another test of working memory capacity consisting of 25 simple arithmetical operations like: "Is (6/3)+1 = 4?" displayed on the screen in groups of three to seven operations, see Appendix 1.2. The subjects had to judge if the suggested operation results were correct or incorrect. The processing time was registered by the computer program. After answering Yes or No a word was presented on the screen for one second. After three to seven operations the subject got the instruction to recall and loudly repeat the words previously displayed on the screen after each operation. Three measures were registered during the operation span test: 1) the number of correctly recalled words, 2) the number of incorrect calculations, and 3) the processing time of the operations.

The number of correctly recalled words of these tests was used to measure the capacity of the phonological loop component of working memory. The processing time used for the arithmetical operations of the operation span test was used to measure the capacity of the central executive of working memory.

Memory test of spoken narrative information. The spoken texts were recorded on CD and were taken from two reading comprehension tests previously used in the Swedish University Test (Högskoleprovet). Two recordings were presented. The subjects listened to one text for 8-9 minutes presented with recorded white background noise and another text for 8-9 minutes presented without the recorded background noise. A pilot study was done to enhance selection of the texts to use. The two selected texts were about different subjects. One had the title "*Körsång*" (Eng. *Choir singing*), was written by Jonas Gustafsson and discussed the history of Swedish choir singing. The other text was "*Medling vid brott*" (Eng. *Mediation in crime*), written by Karin Svanberg and discussed the outcome of 32 pilot projects regarding mediation between victim and offender in different kinds of crime. After listening to each text, the subjects' memory performance was measured in written tests consisting of questions on the content of the spoken texts. There were eight multiple choice questions with the purpose of testing the recognition of the text content, and eight open questions with the purpose of testing recall of detailed information, see Appendices 4.1 - 5.2. The number of correctly answered questions was calculated for the recognition and recall questions separately and together.

2.3.4 Ratings of Effort, Attention and Audibility

Ratings of effort, attention and audibility were done by the subjects for both the noise condition and the control condition, for the hearing tests and the memory tests on the spoken texts. The subjects estimated how well they could hear the sentences and texts on a scale from 1 to 4, where 4 meant that it was possible to hear everything. The attention rating also had a scale from 1 to 4, where 4 meant that it was very easy to keep attention on listening. The effort rating followed Borg's CRT-

scale (Borg, 1998) from 0 to 10, where 0 means *No effort at all* and 10 means *Extremely strong effort*, see Appendix 6.

2.4 Procedure

The experiment was conducted in a sound isolated climate chamber, with the subjects seated at a desk in the middle of the room. The experiment took approximately about 60 minutes and was performed by one subject at a time between eight a.m. and six p.m. The subjects were told to report on an information sheet their age, sex and if they had any hearing impairment, see Appendix 2. They were informed that they were going to perform five different tests:

1) a hearing test in four rounds with and without background noise
2) a listening span test together with one of the hearing tests without background noise
3) a reading span test
4) an operation span test
5) a memory test of two spoken texts, presented with and without background noise

In the hearing test the same six lists of sentences were used for all subjects. The sentences were recorded on CD and were presented in four rounds: two training rounds of 10 sentences each, and then two test rounds of 20 sentences each. The subjects were asked to repeat every sentence aloud, and the number of incorrectly repeated words was used to measure the subjects' hearing ability. For the listening span test the subjects were asked to recall the last word of every sentence.

The two other working memory tests, the reading span and the operation span, were performed on a laptop computer, and the instructions for the different tasks were displayed on the computer screen.

After the working memory tests followed the two recognition and recall tests where the subjects listened to narrative texts with and without noise. Half of the subjects started with a text with recorded background noise and half with a text without the noise. Directly after listening to each text the subjects took the written test consisting of both recognition and recall questions on the text information.

To compensate for transfer and effects of fatigue, and also for the different contents of the two texts, the conditions and texts were counterbalanced with the help of a Latin square. After each condition, the subjects were asked to rate the effort, the audibility and the difficulty of keeping attention to the spoken information.

2.5 Pilot Study

A pilot study with a few subjects was performed prior to the real study, in order to evaluate the different tests and texts before start, and to enable improvements of the test procedure.

2.6 Statistics

Data was analysed using descriptive and inferential statistics. SPSS 14.0 was used. Two-way analysis of variance (noise condition x sequence (or text)) was performed for the recognition and recall tests on the texts. A principal factor analysis with oblique rotation was made of the working memory measures and a two-way analysis of variance was performed for the analysis of the effects of working memory capacity on performance of the memory tests in the noise and control conditions.

2.7 Aspects of research ethics

All subjects were informed that participating in this study was voluntary, and that they at any time, even during the experiment, could terminate without mentioning the cause. Everybody was paid 150 SEK as a compensation for participating. After they finished the tests they were told about the purpose and hypothesis of the study.

3 Results

3.1 Audibility

The audibility was tested both in noise and in a control condition for every subject. The incorrectly perceived words were very few. They were actually more in the control condition (M=.09, SD= .30) than in the noise condition (M=.03, SD=.18) even though the subjects rated the audibility as significantly worse in the noise condition.

3.2 Rating of audibility, attention and effort

Means and *t*-values for self-estimations of audibility, attention and effort are shown in table 1. For all three measures the difference in self-estimation between the noise condition and the control condition was significant.

Table 1. Means (standard deviations) and the results of *t*-tests of the differences between the noise condition and the control condition for estimations of audibility, attention and effort.

	Noise condition	***Control condition***		
Self-estimations	***M(sd)***	***M(sd)***	***t***	***p***
Audibility of the sentences (max = 4)	3.38 (.61)	3.88 (.34)	4.55	.000
Attention keeping of the sentences (max = 4)	2.91 (.64)	3.28 (.52)	3.00	.005
Effort in listening to the sentences (max = 10)	4.48 (2.00)	2.69 (1.52)	7.19	.000
Audibility of the text (max = 4)	2.94 (.80)	3.01 (.30)	6.37	.000
Attention keeping of the text (max = 4)	1.72 (.58)	2.53 (.80)	5.60	.000
Effort in listening to the text (max = 10)	5.98 (2.03)	3.61 (1.93)	5.60	.000

3.3 Reliability analysis of the test questions

Reliability analysis of the test questions, see table 2, showed that the questions of Text 1, *Choir singing*, were reliable and stable between the conditions, especially the recognition questions.

There was a strange result though for Text 2, *Mediation in crime*, which showed negative correlations between the questions in the noise condition. The conclusion must be that these questions were not reliable enough to use to measure recall and recognition performance. It is not meaningful to compute a sum of scores of negatively correlated items.

As the reliability analysis of the questions on the text *Mediation in crime* showed such strange result no analysis of this text is reported. Analyses on both texts were performed though, but they didn't show any significant difference from the results of the analysis on text 1 only. The results of the analyses reported below are therefore only for text 1, *Choir singing*. Half of the subjects (n=16)

listened to this text in the noise condition and half of the subjects (n=16) listened to it in the control condition.

Table 2. Cronbach's Alpha values for the test questions

	Noise condition	***Control condition***	***Total***
Recognition questions on Text 1, *Körsång (Choir singing)*	.707	.734	.713
Recall questions on Text 1, *Körsång (Choir singing)*	.457	.492	.483
Total *Körsång (Choir singing)*			**.741**
Recognition questions on Text 2, *Medling (Mediation*)	-.589	.315	.039
Recall questions on Text 2, *Medling (Mediation)*	-.232	.708	.457
Total *Medling (Mediation in crime)*			**.506**

3.4 Effects of broadband background noise

Figure 1 shows that both the recall and recognition scores were somewhat higher in the control condition than in noise, but *t*-tests showed that neither difference was significant (p>.05).

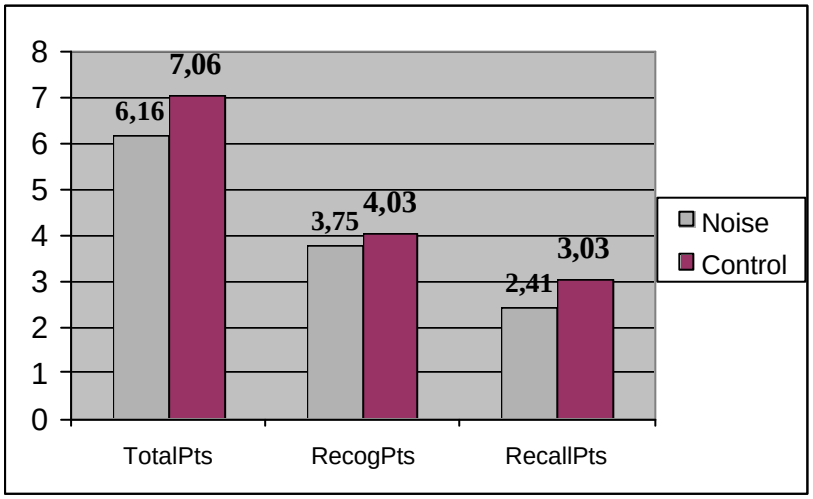

Figure 1. Means for the number of correct answers of the test questions on text 1, *Choir singing*, for the noise condition (n=16) and the control condition (n=16). Means are shown for total points, points on the recognition questions and points on the recall questions.

3.5 Position effect

Figure 2 shows the position effect of the recall and recognition performance. The first 25% of the text was most easily recognised and recalled. This effect was the same for both the noise and the control conditions, but for the last 50% of the text the performance was worse in the noise

condition. The interaction between part and condition had a tendency towards significance (p=.068).

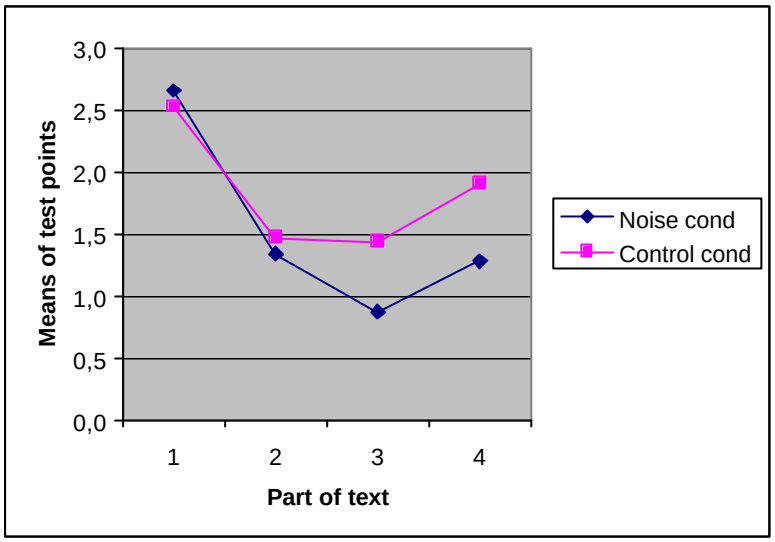

Figure 2. Position effect of recall and recognition questions combined. The mean scores for noise and control conditions per quarter of the text (n=16 in both conditions). Each part represents four questions, two recognition questions and two recall questions.

3.6 Working memory tests

The mean scores for the reading span and operation span tests were quite high (table 3). For those two tests the subjects had to recall 3-7 words each time. The listening span test was more difficult as the subjects had to remember ten words each time and consequently the mean score was lower for this test. The misses were very few in both the reading span and the operation span tests.

Table 3. Means (standard deviations) of scores, misses, and latencies of the working memory span tests.

	M (sd)
Listening span score (max = 20)	13.78 (2.81)
Reading span score (max = 25)	18.94 (3.82)
Operation span score (max = 25)	19.22 (3.79)
Misses (incorrect judgements) reading span	1.53 (1.14)
Response latency reading span (msec)	5377 (2500)
Misses (incorrect calculations) operation span	1.66 (1.83)
Process time operation span (msec)	12199 (4031)

There were significant correlations between the test scores of all three working memory span tests (table 4). There was also a strong correlation between the number of misses (incorrect calculations) and the processing time of the operation span test and also between the number of misses (incorrect judgements) and the response latency of the reading span test.

Table 4. Correlations between the three working memory span tests.

	Listening span score	Reading span score	Operation span score	Misses reading span	Response latency reading span	Misses operation span
Reading span score	0,677**					
Operation span score	0,582**	0,643**				
Misses reading span	0,078	-0,059	0,070			
Response latency reading span	0,264	0,139	0,329	0,605**		
Misses operation span	-0,166	-0,290	-0,455**	0,138	0,095	
Process time operation span	-0,007	-0,220	-0,380*	0,113	0,124	0,805**

** $p < 0.01$ * $p < 0.05$

Cronbach´s Alpha showed a very good reliability of .839 for the sum score of the working memory tests. A principal factor analysis with oblique rotation was done, which showed that the number of correctly recalled words in the three different span tests loaded in the same factor (table 5). The response latency and the number of sentences incorrectly judged in the reading span test formed one factor, and the processing time and the number of operations incorrectly calculated in the operation span test formed another factor. As the misses were very few only the time variable was used to measure the capacity of the central executive component of WM.

Table 5. Structure matrix from a principal factor analysis with oblique rotation of the working memory tests.

Variables	***Factors***		
	1	2	3
Reading span score	,894	,021	-,271
Listening span score	,889	,185	-,061
Operational span score	,808	,260	-,500
Misses reading span	-,010	,897	,110
Latency reading span	,290	,889	,092
Misses operation span	-,290	,112	,937
Processing time operation span	-,152	,111	,950

3.7 Correlations between working memory capacity and recall and recognition performance

There was a significant correlation between the operation span processing time (i.e. the capacity of the central executive component of working memory) and the performance on the recognition and recall tests on the text in the noise condition, but not in the control condition (table 6).

Table 6. Correlations between operation span test processing time and recall and recognition of the text, noise condition (n=16) and control condition (n=16).

	Noise condition (n=16)		*Control condition (n=16)*	
	Pearson Correlation	*p*	*Pearson Correlation*	*p*
Total points	-.728	.001	.152	.573
Recognition points	-.655	.006	.185	.494
Recall points	-.556	.025	.062	.820

On the other hand there was no correlation between the sum of the test scores from the working memory span tests (i.e. the capacity of the phonological loop component of working memory) and the performance on the recognition and recall tests on the text, neither in the noise condition (r=.148, p=.58) nor in the control condition (r=.381, p=.15), and no significant correlations were found between the response latency of the reading span test and test performance on the recognition and recall tests on the text

3.8 Central executive capacity and the effect of noise exposure

To analyse the effect of noise exposure on the recall and recognition performance for subjects having greater and less capacity of the central executive component of working memory, the operation span processing time was dichotomized into short (n=16, M=8.95 seconds, SD=1.88) and long processing times (n=16, M=15.44 seconds, SD=2.75). The difference between the conditions was small. Of the 16 subjects that listened to the text in noise, six had short processing time and ten had long processing time. Of the 16 subjects that listened to the text in the control condition ten subjects had short processing time and six subjects had long processing time.

Two-way ANOVAs were done (condition x OperationSpanProcessTime) which showed significant interactions between condition and operation span processing time for the total score (figure 3) and the recognition score (figure 4) but not for the recall score (figure 5). The figures show clearly that subjects with short processing times actually performed better in the noise condition than in the control condition, and subjects with long processing times (i.e. having less capacity of the central executive component of working memory) performed worse in the noise condition and better in the control condition.

Table 7 shows the significant interactions between condition and operation span processing time for the total scores, $F(1,28)=5.066$, p=.032, and table 8 shows the significant interactions for the recognition scores, $F(1,28)=6.532$, p=.016. As there was no main effect of condition, it was the sensitivity to noise that was greater in the slower group. Table 9 shows the interaction between

condition and operation span processing time for the recall score which was not significant, $F(1,28)=1.070$, $p=.310$.

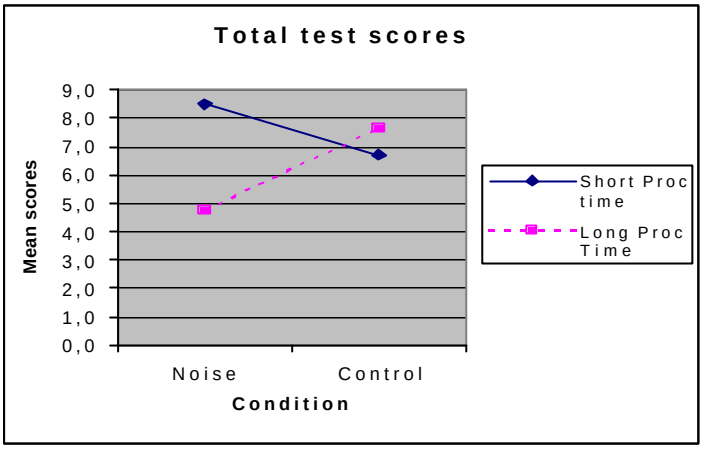

Figure 3. Mean scores for the **total** test performance (recall and recognition questions). Operation span processing time dichotomized into short and long processing times.

Table 7. Analysis of variance for the difference in performance on **both recall and recognition** tests between subjects having short operation span processing time (n=16) and subjects having long operation span processing time (n=16) in the noise condition compared with the control condition.

Source	*SS*	*df*	*MS*	*F*	*p*
Condition (Cond)	2.338	1	2.338	.284	.598
OpSpPrTi (OSPT)	14.526	1	14.526	1.764	.195
Cond X OSPT	41.713	1	41.713	5.066	.032
Error	230.558	28	8.234		
Total	289.135	31			

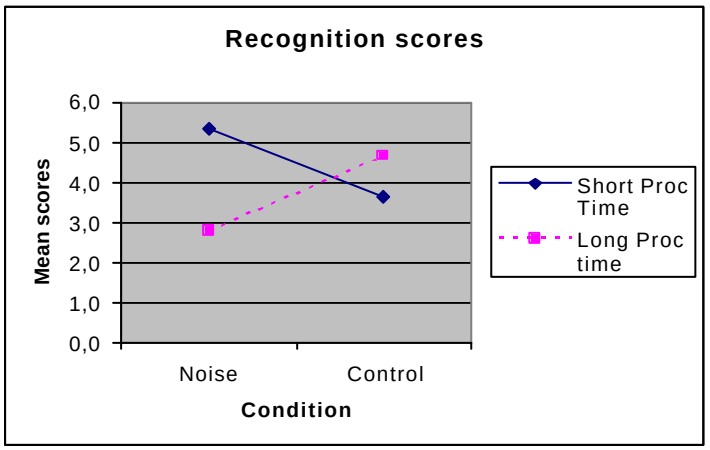

Figure 4. Mean scores for the test performance on the **recognition** questions. Operation span processing time dichotomized into short and long processing times.

Table 8. Analysis of variance for the difference in performance on the **recognition** test between subjects having short operation span processing time (n=16) and subjects having long operation span processing time (n=16) in the noise condition compared with the control condition.

Source	*SS*	*df*	*MS*	*F*	*P*
Condition (Cond)	.063	1	.063	.017	.896
OpSpPrTi (OSPT)	4.313	1	4.313	1.192	.284
Cond X OSPT	23.630	1	23.630	6.532	.016
Error	101.292	28	3.618		
Total	129.298	31			

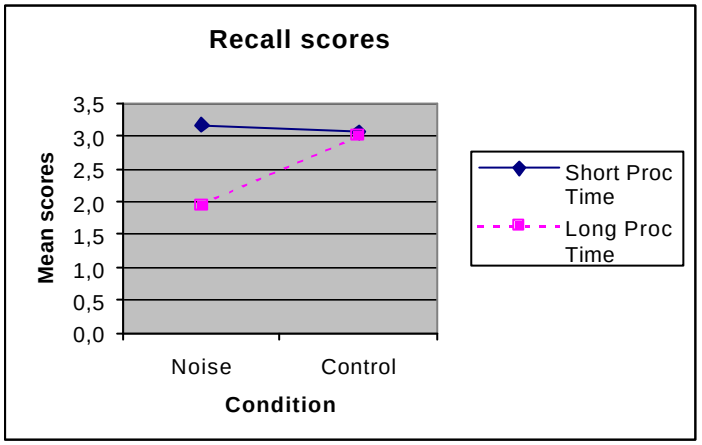

Figure 5. Mean scores for the test performance on the **recall** questions. Operation span processing time dichotomized into short and long processing times.

Table 9. Analysis of variance for the difference in performance on the **recall** test between subjects having short operation span processing time (n=16) and subjects having long operation span processing time (n=16) in the noise condition compared with the control condition.

Source	*SS*	*df*	*MS*	*F*	*p*
Condition (Cond)	1.633	1	1.633	.685	.415
OpSpPrTi (OSPT)	3.008	1	3.008	1.261	.271
Cond X OSPT	2.552	1	2.552	1.070	.310
Error	66.783	28	2.385		
Total	73.976	31			

4 Discussion

4.1 Main result

The results for the three hypotheses were:

- A decrease in recall performance of the orally presented text was predicted for the noise condition, but no main effect of noise could be found, neither for the recall performance nor for the recognition performance.
- It was predicted that the effect of noise would be less in subjects having better working memory capacity. The study showed that noise did have less influence on subjects with better capacity of the central executive component of working memory (measured as shorter processing times in the operation span task). Only subjects with less capacity of the central executive of working memory showed a decrease in recognition performance of the orally presented text in the noise condition.
- It was predicted that no decrease in recognition of information in the text would occur for the noise condition. This hypothesis was falsified as the subjects with less capacity of the central executive component of working memory did show a decrease in recognition but not in recall performance in the noise condition.

4.2 Discussion of result

4.2.1 The influence of working memory capacity

It was predicted that the effect of noise would be less in subjects having greater capacity of working memory (Pichora-Fuller, Schneider & Daneman, 1995; Kjellberg, Ljung & Hallman, 2007). What is new in the present study is that a significant interaction between the capacity of the central executive component of working memory (WM) and performance in the noise condition was found. Noise exposure had a negative effect on recognition performance for subjects with less capacity of the central executive component of WM, but not for subjects with greater capacity. People with greater capacity of the central executive component of WM thereby get less affected by noise when listening to orally presented texts.

Baddeley (2002) assumes that anything that limits attention capacity will impair performance of cognitive tasks. Attention processes are among the main functions of the central executive component of WM. Noise is a factor that disturbs attention. People with less capacity of the central executive should thereby have less capacity for keeping attention to the cognitive task.

What is interesting in the present study is the finding of the importance of the capacity of the central executive component of WM, measured as processing time of *arithmetic* operations, for memory performance of *verbal* information, and also that this has more influence on the memory performance than the capacity of the phonological loop.

In the previous study by Green (2007) no correlation between the WM capacity and the performance in noise was found, but in that study only the *Total words* scoring method of a reading span test was used to measure the WM capacity. As argued above this is rather a measure of the capacity of the phonological loop than that of the central executive. The performance of the arithmetical operations is a more valid measure of the central executive component of working memory as this component is responsible for processing logical operations. The response latency of the reading span test was also registered, but the parallel task in this test (to judge if the sentence content was absurd or not) was considered being too simple to use as a measure of the capacity of the central executive component of WM.

4.2.2 No effect of noise.

Previous studies have examined recognition performance (Rabbit, 1966) and recall performance (Hallman, 2006) of word lists and found that memory performance deteriorates when listening in noisy conditions. Quite few studies have examined the consequences of exposure to noise when listening to narrative texts. The previous study by Green (2007) did find a significant decrease in recall performance in the noise condition but not in recognition performance. In the present study a tendency of effect of fatigue due to noise exposure could be seen in the noise condition (figure 2). Figures 3-5 show that subjects having short processing times in average performed better in the noise condition than in the control condition. The reason for this might be that they concentrated and kept attention extra hard on listening in the noise condition, and as their WM capacity was large they could still manage to store the information for later recall and recognition.

The reason why no significant main effect of noise was found in the study could be:

- There is no effect of noise on spoken texts, at least not for the length of texts used in this study. It might be that a significant effect could be found for longer texts, which require more of attention and concentration.
- The subjects with greater capacity of the central executive component of WM performed better in the noise condition. This somewhat outbalanced the total result.
- Larsby, Hällgren, Lyxell & Arlinger (2005) found that noise with temporal variations was most disturbing. The present study used broadband noise with a steady sound level of 59 dB, which should have a less disturbing effect, which might not have been large enough to get significant main effects of noise exposure.

- The test questions showed low reliability for one of the test texts in the noise condition. A better test instrument might have resulted in significant main effects of noise exposure for both recognition and recall performance.

4.3 Discussion of method

4.3.1 Rating of audibility, attention and effort

Self-estimations of audibility, attention and effort showed significant differences between the noise and control conditions for both the sentences and the texts (table 2). Audibility and attention got lower values and effort higher values for the noise condition. This is what would be expected. These self-estimations presumably showed greater differences between the conditions than really was the case. The validity of the audibility ratings is questionable as the incorrectly perceived words were less in the noise condition than in the control condition. The subjects probably had the conception that they ought to give different estimations for the two conditions. Even though the subjects could perceive all words correctly in the noise conditon, their strain and effort in this condition might have resulted in the impression that the audibility was worse than it really was. This is what would be expected, as the purpose of the experiment was that the noise condition should be more straining.

4.3.2 Audibility

The method used to test the audibility was improved in several respects from the experiences made in the previous study by Green (2007): normal sentences were added and used together with the Hagerman sentences, and all subjects got two training rounds, one with background noise and one without. The audibility test showed that the incorrectly perceived words were very few, and that they were actually more in the control condition (M=.09) than in the noise condition (M=.03), even though the subjects rated the audibility as significantly worse in the noise condition. This might have been caused by the fact that the control condition was performed together with the listening span test, which probably resulted in an extra load on the subjects' working memory, as they had to divide their attention between listening and phonological rehearsal. The extra load caused by phonological rehearsal might have been larger than the extra load caused by the noise.

4.3.3 The recall and recognition test instruments

Cronbach's Alpha values on the test questions showed a very low reliability for the text *Mediation in crime* in the noise condition – but not in the control condition. There were even *negative* correlations between the questions in the noise condition. It is completely incomprehensible why

there should be negative correlations at all, and even more why they came up only in the noise condition.

To get reliable measures of memory performance a validated test instrument must be used. The test questions on the *Choir singing* text, were reliable enough for both conditions, so the test results for these could be used for a between subjects analysis. Thereby both the experiment group and the control group became half size to what was intended. This lowered the power of the study. It would of course have been better to have larger groups of subjects to ensure valid and reliable results.

Cronbach's Alpha values for the recognition questions on the *Choir singing* text were better than for the recall questions. It was also for the recognition questions that a significant effect of noise exposure could be found for subjects with less working memory capacity. A better test instrument might have resulted in a significant effect of noise for the recall performance as well.

4.3.4 The working memory span test instruments

The relationship between working memory, arithmetic ability, and the cognitive impairment of children with difficulties in mathematics was examined by Passolunghi & Siegel (2004). A group of children with difficulties in mathematics was compared with a group of children with a normal level of achievement. The children were required to perform a variety of working memory and short-term memory tasks. The results suggest a general working memory deficit in children with difficulties in mathematics, specifically in the central executive component of Baddeley's model and primarily in the ability to inhibit irrelevant information. However, these children were not impaired in speech rate and counting speed tasks, which mainly involve the role of the phonological loop. The findings by Passolunghi & Siegel (2004) indicate a close correlation between arithmetic performance and the capacity of the central executive component of working memory. The use of the processing time of the arithmetic operations of the operation span test must consequently be a valid measure of the capacity of the central executive component of WM.

4.4 General Discussion

4.4.1 The consequences of the results for theories within this area

The finding of the effect of working memory capacity on the performance in the noise condition is in line with the theories of Pichora-Fuller, Schneider & Daneman (1995) and the findings by Kjellberg, Ljung & Hallman (2007).

The present study contributes with significant results regarding the negative effect of noise exposure on recognition performance for people with less WM capacity, and especially the capacity of the central executive component of WM, when listening to narrative texts.

4.4.2 The practical relevance of the results

People with greater capacity of the central executive component of WM get less affected by noise when listening to texts, which also means that people with less capacity of the central executive component get more affected by noise.

Several studies have shown that there is a correlation between WM capacity and intelligence. Oberauer, Schulze, Wilhelm & Süss (2005) argue that general intelligence (*g)* and WM capacity are very highly correlated, that WM capacity should be regarded as an explanatory construct for intellectual abilities, and that it is a very strong predictor of reasoning ability and also predicts general fluid intelligence and *g*.

Friedman et al. (2006) showed that the executive function *updating* was highly correlated with intelligence measures, but the *inhibiting* and *shifting* functions were not. The inhibiting functions were tested by tasks that required suppressing dominant or automatic responses, such as the Stroop task. The shifting tasks required participants to switch between subtasks. The updating tasks required adding and deleting information in WM.

The arithmetical operations of the operation span test are of updating nature which indicates that operation span performance should be correlated with general intelligence. The subjects in the present study who performed better in the operation span test were less affected by noise. This means that noise exposure should affect low-achieving students much more than it affects high-achieving students. It is therefore essential for all people with less capacity of the central executive component of WM to have quiet surroundings when working intellectually or studying.

4.4.3 Suggestions of further research

No main effect of noise was found in this study, probably due to weaknesses of the test instrument. More studies on the cognitive consequences of exposure to noise when listening to narrative texts are needed. These studies should use well validated test instruments and should be performed on larger groups of subjects. The test instruments should include both recognition and recall performance of orally presented texts in noisy conditions.

There is also a need for more research on the effects of noise on subjects with greater and less capacity of the central executive component of WM. To ensure validity, studies need to be performed for larger groups. The subjects with greater capacity of the central executive component of WM performed better in the noise condition than in the control condition in the present study. It would be interesting to examine if this is always the case.

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Reading Span Test

Pappan kramade **dottern** *Uppvärmning*
Räven åt **poesi** *Uppvärmning*

	Rätt	**Fel**
Flickan sprang **fort**	?	?
Tallen barrade **baklänges**	?	?
Huset var **trött**	?	?
Pucken rullade **iväg**	?	?
Bonden läste **tidningen**	?	?
Munken rökte **tåg**	?	?
Hammaren var **lycklig**	?	?
Hinken var **tom**	?	?
Molnet svävade **bil**	?	?
Ekorren hoppade **bio**	?	?
Tåget åkte **norrut**	?	?
Kjolen passade **bra**	?	?
Yxan var **slö**	?	?
Äpplet ruttnade **igelkott**	?	?
Senapen smakade **gott**	?	?
Stugan måste **björn**	?	?
Pojken sprang **tidningen**	?	?
Tulpanen blomstrade **vackert**	?	?
Hallonen mognade **tidigt**	?	?
Filmen slutade **yoghurt**	?	?
Haren skuttade **snabbt**	?	?
Studenten kom **sent**	?	?
Pappan kokade **dammsugare**	?	?
Flugan flög **cykel**	?	?
Bilen **backade sked**	?	?

Antal rätt: _____

Appendix 1.1

Operation Span Test

Är (2 x 3) + 1 = 7 ? **Stol** *Uppvärmning*
Är (4 / 2) – 1 = 5 ? **Kaffe** *Uppvärmning*

		Rätt	Fel
Är (3 x 2) - 1 = 8 ?	**Salt**	?	?
Är (4 / 2) + 1 = 3 ?	**Ros**	?	?
Är (2 x 2) + 1 = 6 ?	**Fluga**	?	?
Är (2 x 4) - 2 = 6 ?	**Kök**	?	?
Är (3 x 4) - 3 = 8 ?	**Björk**	?	?
Är (12 / 3) + 1 = 5 ?	**Tvål**	?	?
Är (4 x 4) - 3 = 13 ?	**Skata**	?	?
Är (4 / 2) + 3 = 6 ?	**Väg**	?	?
Är (2 x 3) + 1 = 7 ?	**Socker**	?	?
Är (2 x 2) + 5 = 8 ?	**Badrum**	?	?
Är (4 x 2) + 1 = 9 ?	**Viol**	?	?
Är (12 / 4) + 1 = 5 ?	**Peppar**	?	?
Är (2 x 4) - 2 = 6 ?	**Handfat**	?	?
Är (4 x 2) + 1 = 7 ?	**Katt**	?	?
Är (2 x 3) + 3 = 9 ?	**Soffa**	?	?
Är (9 / 3) + 4 = 8 ?	**Anka**	?	?
Är (4 x 3) - 5 = 7 ?	**Vitlök**	?	?
Är (2 x 5) - 2 = 7 ?	**Bio**	?	?
Är (4 x 1) + 1 = 7 ?	**Polis**	?	?
Är (2 / 2) + 1 = 3 ?	**Gunga**	?	?
Är (8 / 4) + 1 = 3 ?	**Matta**	?	?
Är (2 x 3) - 2 = 4 ?	**Pion**	?	?
Är (6 / 2) - 1 = 2 ?	**Mjöl**	?	?
Är (2 x 3) + 2 = 7 ?	**Gås**	?	?
Är (8 / 2) - 1 = 5 ?	**Mygga**	?	?

Antal rätt: _____

Appendix 1.2

Tack för att du vill medverka i den här undersökningen

Ditt deltagande är helt frivilligt och testerna är konfidentiella, vilket innebär att ingen kommer att kunna se dina resultat på experimentet.

Som tack för din medverkan kommer du att erhålla en ersättning om 150 kronor.

Försök att genomföra testet så noga som möjligt.

Bakgrundsfrågor

1. **Födelseår _____**
2. **Är du**

   ? Kvinna

   ? Man

3. **Har du någon form av hörselnedsättning? _____**

Appendix 2

Meningar <u>utan</u> bakgrundsbrus - träningsomgång

Hagermanmeningar lista H1	Hörtest
1. Britta flyttar åtta svarta ringar	_____
2. Elsa gav sex nya vantar	_____
3. Peter köpte sju ljusa skålar	_____
4. Karin ägde fyra vackra knappar	_____
5. Bosse visar tre lätta dukar	_____
6. Anna höll två mörka korgar	_____
7. Jonas lånar elva hela lådor	_____
8. Svante tog arton gamla bollar	_____
9. Gustav ser nio fina pennor	_____
10. Märta har tolv stora mössor	_____

Appendix 3.1

Meningar <u>med</u> bakgrundsbrus – träningsomgång

Hagermanmeningar lista H2	Hörtest
1. Elsa ägde nio fina pennor	_____
2. Gustav lånar två gamla lådor	_____
3. Bosse hav sju mörka bollar	_____
4. Britta visar arton stora knappar	_____
5. Peter flyttar åtta ljusa skålar	_____
6. Svante tog tolv hela dukar	_____
7. Märta har elva lätta korgar	_____
8. Karin höll fyra vackra mössor	_____
9. Jonas köpte sex nya vantar	_____
10. Anna ser tre svarta ringar	_____

Appendix 3.2

Meningar <u>utan</u> bakgrundsbrus – test

Hagermanmeningar lista H3	Hörtest	Minnestest
1. Gustav ser tolv svarta skålar	_____	_____
2. Jonas flyttar sju ljusa lådor	_____	_____
3. Märta köpte fyra hela mössor	_____	_____
4. Elsa lånar tre mörka vantar	_____	_____
5. Karin visar åtta gamla dukar	_____	_____
6. Bosse ägde sex vackra ringar	_____	_____
7. Peter gav två stora bollar	_____	_____
8. Britta tog arton nya pennor	_____	_____
9. Svante har nio fina knappar	_____	_____
10. Anna höll elva lätta korgar	_____	_____

Antal rätt i minnestest: _____

Meningar med redundans lista R3	Hörtest	Minnestest
1. Bilen fick en buckla på **skärmen**.	_____	_____
2. Ida har tappat sin första **tand**.	_____	_____
3. Städerna ligger tätt i **Holland**.	_____	_____
4. Banken stänger klockan **fem**.	_____	_____
5. Tullen hittade flera **flaskor**.	_____	_____
6. Tjuven stal hela **dagskassan**.	_____	_____
7. Tiggaren fick pengar till **mat**.	_____	_____
8. Musikanten spelade en gammal **polka**.	_____	_____
9. Tvätta händerna i tvål och **vatten**.	_____	_____
10. Vänern är Sveriges största **sjö**.	_____	_____

Antal rätt i minnestest: _____

Tot antal rätt minnestest: _____

Appendix 3.3

Meningar med bakgrundsbrus – test

Hagermanmeningar lista H4	Hörtest
1. Peter köpte två fina knappar	_____
2. Bosse gav sex nya dukar	_____
3. Britta flyttar fyra lätta vantar	_____
4. Anna höll tre vackra ringar	_____
5. Svante visar åtta stora pennor	_____
6. Karin tog tolv mörka lådor	_____
7. Elsa lånar arton hela bollar	_____
8. Jonas ser elva svarta mössor	_____
9. Märta ägde nio gamla korgar	_____
10. Gustav har sju ljusa skålar	_____

Meningar med redundans lista R4	Hörtest
1. Böckerna står tätt i bibliotekets hylla.	_____
2. Skridskorna behöver slipas ofta.	_____
3. Storken är en sällsynt fågel i Skåne.	_____
4. Regnet föll i häftiga skurar.	_____
5. Potatisen blommar redan på fälten.	_____
6. Slå inte spiken för hårt i väggen.	_____
7. Katten har gömt sina ungar för räven	_____
8. Björkarna är gula i mitten av september.	_____
9. Apelsinerna kommer från södra Spanien.	_____
10. Flygplanet kretsade lågt över målet.	_____

Appendix 3.4

Frågor till texten KÖRSÅNG – Ringa in rätt svar!

1. Hur bör man enligt texten i första hand betrakta studentsången?

a. Som ett resultat av ett förändrat musikklimat.
b. Som en kompromiss mellan dåtida musikgenrer.
c. Som ett fenomen som förändrade det offentliga musiklivet.
d. Som ett kortlivat och socialt isolerat musikexperiment.

2. Var fanns flerstämmig manssång före 1840, förutom i studentkörerna i Uppsala och Lund?

a. Inom väckelserörelsen och nykterhetsrörelsen.
b. Inom ordnar, regementen och musiksällskap.
c. Inom arbetarrörelsen.
d. Inom frivilliga skarpskytteföreningar.

3. **På vilket sätt utövade studentsången, enligt textförfattaren, inflytande på de stora folkrörelserna: arbetarrörelsen, väckelserörelsen och nykterhetsrörelsen.**

a. Fosterländska sånger togs upp och stöptes om eller parodierades av folkrörelsernas körer.
b. De akademiska körerna blev förebilder för folkrörelserna vad gällde den unisona sången.
c. Den patriotiska traditionen fick indirekt folkrörelsesången att markera avstånd till kyrkan.
d. Nationalistiska texter imiterades lika flitigt inom folkrörelserna som bland studenterna.

4. **Vad, förutom att vara ett musikaliskt nöje, utgjorde den unisona sången för sina utövare?**

a. En skolning i allsidig musikuppfattning.
b. En symbol för frihetssträvanden.
c. Ett ställningstagande för frikyrkligheten.
d. En arena där samhörighet och engagemang för en sak kunde manifesteras.

5. Hur påverkade studentsångarna läroverkens musikliv?

a. Den unisona sången växte fram där som en motreaktion mot den flerstämmiga studentsången.
b. Läroverken blev en plantskola för universitetens musikliv.
c. Läroverkseleverna parodierade på manskörernas fosterländska sånger så att textinnehållet blev det rakt motsatta.
d. Musiklärarna ansåg att studentsångerna kunde åstadkomma både moralisk och fysisk hälsa.

6. **När fick den unisona sången sin startpunkt?**

a. När Harmoniska Sällskapet bildades
b. När frivilliga skarpskytteföreningar inrättade köravdelningar
c. När folkhögskolan grundades
d. När studentsångerna spreds till läroverken

7. **Textförfattaren beskriver sekelskiftets strid mellan den unisona och den flerstämmiga sången. Vilka var de huvudsakliga motpolerna i denna konflikt?**

a. Den traditionella kyrkosången och folkrörelsesången.
b. Den patriotiska sången och den traditionella kyrkosången.
c. Folkrörelsesången och studentsången.
d. Studentsången och den patriotiska sången.

Appendix 4.1

8. **Distinktionen mellan den unisona sången och den flerstämmiga studentsången bottnar i två skilda musikbildningsideal. Vilka?**
    a. Populärestetiken och en instrumentell bildningssyn.
    b. Populärestetiken och uppfattningen att alla kan sjunga.
    c. En instrumentell bildningssyn och uppfattningen att musikalisk skaparförmåga är få förunnat.
    d. En instrumentell bildningssyn och den klassiska musikpedagogiken.

Svara med egna ord på följande frågor:

9. Avsluta sista ordet i meningen: ”Det kan hävdas att allmänt förekommande gemensam sång, folkmusik i egentlig mening, under lång tid utgjordes av _____.”

10. Hur spreds körintresset till Stockholm?

    _____

11. I vilka två städer fanns musiksällskapet Par Bricole före 1840?

    _____

12. Vad menas med *architext* i detta sammanhang?

    _____

13. Fyll i det saknade ordet i meningen: ”Inte minst förknippades den allmänna sången i sångföreningar ofta med en gryende _____, men också med natursvärmeri och vurm för folkvisor.”

14. Fyll i det saknade ordet i meningen: ”Den moraliska hälsan skulle stärkas av att folkvisor och _____ sånger sjöngs.

15. Hur många stämmor hade de flerstämmiga studentsångerna?

    _____

16. Vad innebär populärestetiken som musikbildningsideal?

    _____

Frågor till texten MEDLING VID BROTT - Ringa in rätt svar!

1. **Hur uppstod medlingen som metod enligt texten?**
   a. Spontant genom en enskild polismans initiativ.
   b. Genom socialtjänstens verksamhet.
   c. På initiativ av Brottsförebyggande rådet
   d. Genom ny lagstiftning på området.

2. **Vad var syftet med BRÅs försöksverksamhet?**
   a. Att få en bild av hur offer och gärningsman upplever medlingen
   b. Att ge regeringen underlag för beslut om lagstiftning på området
   c. Att gärningsmannen ska få kunskap om brottets konsekvenser
   d. Att upprätta avtal mellan offer och gärningsman

3. **Hur stor andel av försöksprojektens medlingar var hänvisade från polisen?**
   a. Ca 30%
   b. Ca 50%
   c. Ca 70%
   d. Ca 90%

4. **BRÅ har enligt texten genomfört två kvalitativa studier kring ett mindre antal av medlingarna. Vad visade dessa studier?**
   a. Att lagstiftning på området behövs
   b. Att gärningsmännen upplevde att medlingen främst var till för brottsoffret
   c. Att det behövs en analys av problembilden på orten
   d. De gav en bild av hur offer och gärningsmän upplevde medlingarna

5. **Hälften av medlingarna i studien gällde gärningsmän i en viss åldersgrupp. Vilken?**
   a. Gämingsmännen var under 15 år
   b. Gärningsmännen var 15-17 år
   c. Gärningsmännen var 15-18 år
   d. Gärningsmännen var över 18 år

6. **Vad vilken typ av brott har de dialoginriktade medlingarna främst använts?**
   a. Vid lindrigare brott riktade mot företag.
   b. Vid allvarligare brott riktade mot företag.
   c. Vid lindrigare brott riktade mot privatpersoner.
   d. Vid allvarligare brott riktade mot privatpersoner.

7. **Vad står vanligen i fokus i de mer dialoginriktade medlingarna?**
   a. Brottets materiella konsekvenser, ekonomisk gottgörelse
   b. Att få gärningsmannen att förstå att polisen kommer att hålla ögonen på honom.
   c. Såväl gärningsmannens som brottsoffrets behov sätts i första rummet
   a. Att kartlägga den lokala kriminaliteten.

8. **Hur kan man enligt textförfattaren förbättra de enskilda medlingarna?**
   a. Genom att upprätta konkreta avtal mellan parterna.
   b. Genom att lägga mindre betoning på brottets materiella konsekvenser.
   c. Genom att ge medlingsverksamheten en gemensam huvudman.
   d. Genom att utgå från en analys av problembilden på orten

Appendix 5.1

Svara med egna ord på följande frågor:

9. När startade det första svenska medlingsprojektet?

   _____

10. I vilken stad startade det?

    _____

11. Vilken huvudman hade de flesta medlingsprojekten inom BRÅs försöksverksamhet?

    _____

12. Ungefär hur många medlingar ingick i BRÅs försöksprojekt under försöksåret?

    _____

13. Komplettera följande mening: ”De intervjuade brottsoffren, som utsatts för brott i egenskap av privatpersoner, uppger alla att de upplevt _____ efter medlingen.”

14. Vilken typ av medling gäller projekt vars syfte är att ”stämma i bäcken”?

    _____

15. Komplettera följande mening: ”De flesta snatterimedlingar tog under försöksåret mindre än _____ .”

16. Avsluta meningen: ”En ny undersökning från BRÅ om återfall i brott visar att sannolikheten att återfalla i brott är låg om man, första gången man lagförs för brott, lagförs för _____.”

Appendix 5.2

Skattningar

Hur bra gick det att höra vad som sades?

Ringa in den siffra som bäst motsvarar hur väl orden hördes

1 Vart femte ord eller fler var omöjligt att höra
2 Ungefär vart tionden ord var omöjligt att höra
3 Det var bara några enstaka ord som inte gick att höra
4 Det var möjligt att höra i stort sett varje ord som sades

Hur väl lyckades du hålla uppmärksamheten på vad som sades?

Ringa in den siffra som bäst motsvarar hur svårt det var att vara uppmärksam

1 Det var mycket svårt att hålla uppmärksamheten på vad som sades
2 Det var ganska svårt att hålla uppmärksamheten på vad som sades
3 Det var ganska lätt att hålla uppmärksamheten på vad som sades
4 Det var mycket lätt att hålla uppmärksamheten på vad som sades

Hur stor ansträngning krävdes det för att lyssna?

Ringa in den siffra som bäst motsvarar din ansträngning

0	**Ingen alls**
0,3	
0,5	**Extremt svag**
0,7	
1	**Mycket svag**
1,5	
2	**Svag**
2,5	
3	**Måttlig**
4	
5	**Stark**
6	
7	**Mycket stark**
8	
9	
10	**Extremt stark**

Appendix 6