

# Reading in a noisy environment: Are test principles realized in a reading test procedure for children also useful in studies with adults?

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## Introduction

Reading is a very important ability. This of course holds for the everyday life of school children, where the reading ability is frequently used. But this also holds for many situations in professional life, e.g. for office jobs, jobs in open service areas, or, in general, for all kinds of jobs, where instructions or information are given in written form. From studies on noise effects on humans it is known that unwanted sounds can disturb tasks which involve cognitive performance. This is for example well documented since many years for the effects of speech sounds on working memory [1], but there are also studies which show that particular sounds have detrimental effects on reading performance [2]. In order to protect employees from possible detrimental sound effects, it is necessary to know as much as possible about what kind of noise affects reading to what amount.

It is therefore typical for studies on noise effects to define specific sound conditions more or less in detail, and to compare reading performance in the different conditions. This valuable and essential approach should be complemented by the question, how we can find or design a reading task that really allows capturing possible effects and that is suitable for a typical design of this type of studies. This question is the background for this contribution.

In an investigation on effects of *acute noise* on reading the chosen reading task should of course really capture the reading ability in general, but it is also essential that the task is sufficiently sensitive to noise. "Noise sensitivity" means that the task should uncover whether the sound affects the reading performance, and in the best case it should also be able to distinguish between the effects of different kinds of noise. This is not directly fulfilled for every test procedure, because a conventional reading test is typically developed with the aim to be a diagnostic instrument, which is not automatically the same as being an instrument to measure effects of noise.

One approach in studies on noise effects - mainly in studies with adults - is to construct an own test procedure for the particular investigation. Disadvantages of self-made procedures are that a comparison with a normative group is not possible, and also that there is no chance for a detailed a-priori check of all the quality measures usually applied to characterize the psychometric properties of a test procedure, as is done for standardised tests. Still, the construction of an own test procedure comes with the big chance to take the current knowledge about noise effects into consideration, and it can also be adapted to the specific setting of the research question in order to strengthen its "ecological validity" - e.g. reading of typical job-related texts in a study on noise effects in an open plan office.

Several years ago a reading task was developed by the first author [3] for use in a large study on the effects of traffic noise on cognitive performance in children (see BMBF research network "Leiser Verkehr" (Low noise traffic); [www.fv-leiserverkehr.de](http://www.fv-leiserverkehr.de); sub-project 2222). This reading task is named OKiLeLe for Oldenburger Kinder-Leise-Leseaufgabe. Currently we are interested in noise effects on cognitive performance in adults, and the question arose again: What kind of reading test procedure should be applied in order to capture possible noise effects? The OKiLeLe task was now applied in an explorative study with adults in order to evaluate whether the realised test principles in this procedure would in general also be appropriate to investigate noise effects in adults. Based on these findings the goal is to develop a modified procedure that is suitable for studies with adult participants.

## The self-developed reading test procedure

While developing the reading task the aim was to create a procedure that includes the current knowledge about noise effects on reading, and that was appropriate in the given research context. The task for the children in this procedure is to find mistakes in written sentences. The procedure has two parallel versions with 48 items each. The items consist of one or two sentences, and 36 out of the 48 items contain one mistake. Half of the mistakes are realised as grammatical and half as semantic mistakes.

The task was applied in different traffic noise conditions. It revealed differences in reading performance with respect to the specific sound conditions. The "error percentage" in the task turned out to be one very important outcome measure. With respect to the different sound conditions, the traffic density was shown to be the more affecting factor than the spectral modification realised in that study [4]. Of course, the procedure needs to be tested in further sound conditions in order to be able to generalise the results from this specific study and to optimise the item set. But the overall conclusion of the previous study was that the new test procedure is in principle suitable for studies on noise effects on children.

## The current study

The current explorative study was carried out in two parts, a group setting ( $n=33$ ; max. 8 persons/group) and a single test setting ( $n=10$ ). Overall three different tests were applied, the described reading test and two different attention tests. In this contribution, results from the reading test and from one of the attention tests referring to the group setting are shown.

## Methods

**Participants:** In this part of the study 11 men and 22 women participated (age: 21 to 37 years).

**Room and time:** The measurements were carried out in a typical small lecture room during the evening between 18:30 h and 19:30 h. The tests were allocated to two sessions one week apart, each session lasted about one hour.

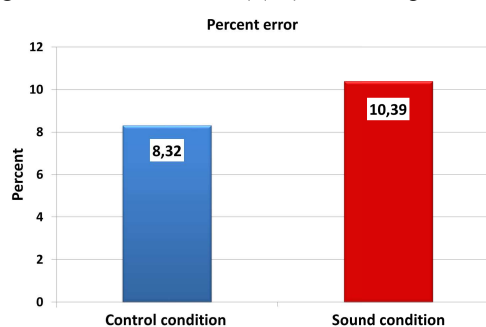
**Test procedures:** The reading test was applied with a different instruction than in the previous study with children. There was a time limit of 50 s per page (four pages in total). In addition to the reading task participants worked on the FAIR-2 procedure [5]. In this attention test visually similar symbols have to be found and marked in a specific way. Participants had to work on two sheets, with three minutes time for each sheet.

**Design:** All participants worked on all test procedures. Each task was carried out in a control condition and in a speech noise condition.

**Sound conditions:** The speech noise was part of an audio drama in German language, with different speakers in different room conditions (Leq 62dB(A)). The sound was presented via two loudspeakers which were positioned at the front of the room. The control condition was fairly quiet. It was the “natural” background sound in a seminar room occupied by up to eight people during evening hours.

## Results

**Reading Test - Noise condition versus control condition:** The statistical analysis (*t*-tests for pairwise comparisons) for the number of items completed correctly and for the percent error values revealed significant differences between both conditions (correct:  $t(30) = 2.879$ ,  $p < 0.05$ ; percent error:  $t(30) = -2.057$ ,  $p < 0.05$ , see Fig. 1). A further analysis of the percent error values also considering the factor “experimental mistake” (semantic, grammatical) showed: (1) It was easier to find the semantic mistakes than the grammatical mistakes. (2) A tendency effect for the difference between the results in both sound conditions was only given for the grammatical mistakes ( $t(30) = -1.866$ ,  $p = 0.072$ ).



**Figure 1:** Percent-error in the control and the sound condition in the reading test ( $n=31$ ).

**Attention Test - Noise condition versus control condition:** In this test most of the participants achieved a high number of overall and correctly completed symbols. The analysis carried out for these values did not show significant differences between the control and the sound condition. An analysis considering also the sequence of experimental conditions revealed that there are different results in different sub-groups. Because in total there were further (test) conditions additional analyses need to be carried out in order to clarify the influence of these aspects on the results.

## Summary and Conclusion

A reading test procedure that originally had been developed for a study on noise effects in children was applied in a study with adults. Although the sentences are very easy for adults the performance showed a wide range across participants. This means, the procedure can distinguish between different levels of reading performance. In addition, significant effects of speech noise on performance were revealed. The conclusion therefore is that even the original version of this procedure can in principle be used in studies with adults.

However, it is still the aim to create a similar procedure along the new results which should be optimised with respect to the construction principles and which should also be most appropriate referring to the speech material for typical professional settings. Based on the current results it can be derived which features realised in the test items are also useful in studies with adults and which features should be realised in a modified way or, respectively, which types of items should be replaced because of their poor sensitivity to noise.

The result observed for semantic and grammatical mistakes provides a very good basis for an initial modification. The solution, however, will not be to remove all items with semantic mistakes and to keep only the items with grammatical mistakes, because the very mixture of different types of items makes the procedure “lively”. Although the inclusion of orthographic mistakes would be of high ecological validity, it was shown in other studies that finding those mistakes is not affected by speech sounds in general [6]. A more detailed analysis of the current data including the effects of sentence length will be carried out to get to more hints for the optimisation of the procedure. All in all, the results from the current study emphasize that it is important to keep an eye on the concrete test procedure employed in a study on noise effects, in order to avoid misleading results concerning detrimental effects.

## References

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