

# LISTENING TO SPEECH IN NOISE: EVALUATION AND TRAINING

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## 1 Introduction

Having a conversation in noise is a challenge for everyone. This could be a disabling situation for individuals with hearing problems, especially for those with auditory processing disorder (APD). APD “is presumed to originate in the auditory system and is characterized by a persistent limitation in the performance of auditory activities and significant consequences on participation” [1] (p. 13). Close to 60% of children with APD and normal hearing sensitivity, being involved in a rehabilitation program, failed a speech in noise test [2]. This also seen in adults who report difficulty in hearing in noise, despite the fact that they have a normal audiogram [3,4]. Although, this listening difficulty in individuals with APD is well known, there are only a few studies conducted on the efficacy of a listening training programs in noise in children [5,6].

Maggu et Yathiraj (2011) [5] exposed five children suspected of APD to an auditory training program where they listened to short stories in noise at several signal to noise ratios and answered questions, over 15 to 20 training sessions of 25 minutes. Five children with also suspected APD did not participate to the training. Results showed that after the training program, there was a significant improvement on speech in noise tests in the experimental group, but not in the control group. In a study by Loo et al. (2016) [6], 20 children with APD participated to an auditory training program where they had to identify words presented in noise as well as digits and words in a dichotic listening task. They also listened to stories in noise. The training was over 12 weeks with five 30-minute sessions/week. Nineteen children with APD did not take part to the training as the control group. Results showed, that the experimental group improved significantly their performance on identifying sentences in noise relative to the control group, following the end of the training. No known study was found in the literature related to this topic in adults with APD.

The present document reports results collected in three pilot studies among children with APD or adults complaining of listening difficulties in noise. The objective aimed to examine, in part, the benefits of a desensitization to noise therapy in children and in adults on speech perception in noise.

## 2 Method

### 2.1 Participants

In the study 1 (S1), ten 8-12 year-old children with APD with normal hearing sensitivity participated in the study. Five were in the experimental group who received the listening training in noise and five in the control group (no training). More children were involved in study 2 (S2), ten took part in the therapy sessions and six did not. In study 3 (S3), nine adults with normal hearing sensitivity, complaining of listening difficulties were involved in the pilot study. Four were exposed to the noise desensitization therapy and five did not receive any therapy.

### 2.2 Material and Procedure

In the three studies, stimuli were composed of words, sentences and short stories, presented at comfortable level through a CD player in S1 and through headphones connected to a computer for S2 and S3. In S1, the stimuli were supported with pictures while in S2 and S3, they were presented with a software program developed for the experiment (*Logiciel d'écoute dans le bruit – LEB*, meaning Listening in noise software). For S1, children in the experimental group participated in nine 60-minute sessions, one session/week. In S2 and S3, it was two sessions of 30 minutes/week during 9 to 13 weeks. During the sessions, children took part in activities of word discrimination, word identification, sentence identification, comprehension of directions, comprehension of complex sentences and comprehension of short stories. In the three studies, the signal to noise ratio was adapted according to the performance of the participants.

Pre- and post-training measures included speech in noise tests. In S1 and S2, the Hearing In Noise Test (HINT), adapted in French [7], was used. It is composed of sentences presented in quiet and in noise. The sentences were delivered through a speaker standing one meter in front of the participant. In the noise condition, a speaker was also located at 90 degree on each side of the child at one meter distance. The child had to repeat the sentences heard. In S3, the *Test de mots dans le bruit* (TMB, meaning Word in noise test) [8] was utilized. Thirty-five monosyllables were sent through headphones, connected to an Astera audiometer. In each ear, the level was set at 60 dB HL and a babble noise was heard at 55 dB HL simultaneously. The adult participants had to identify the words heard.

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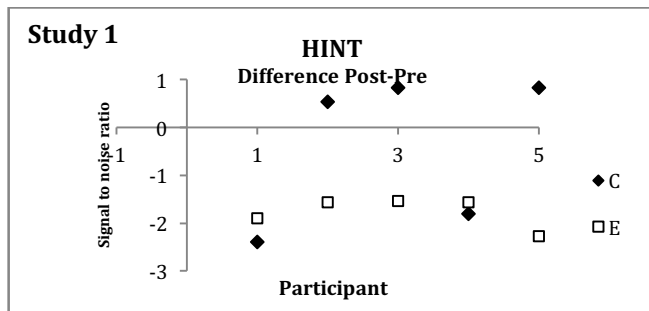
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### 3 Results, Discussion and Conclusion

No statistical analyses were performed because of the limited number of participants in the studies. Data observation is reported, comparing the distribution of the participants in each group according to the benefits revealed by the improvement in performance. In S1 and S2, the difference between pre- and post-training performance obtained on the HINT was calculated. This performance corresponded to the signal to noise ratio where 50% of correct sentences were corrected repeated.

In S1, results showed that all participants (100%) in the experimental group improved their performance on the HINT (Figure 1). Indeed, the signal to noise ratio decreased by at least more than 1 dB after the end of the training program compared to the pre-training results. In the control group, an improvement in performance (i.e., lower SNR) was present in two of the five participants (40%). However, these two participants had a greater increase (average -2.1 dB) in performance than the participants in the experimental group (average -1.8).



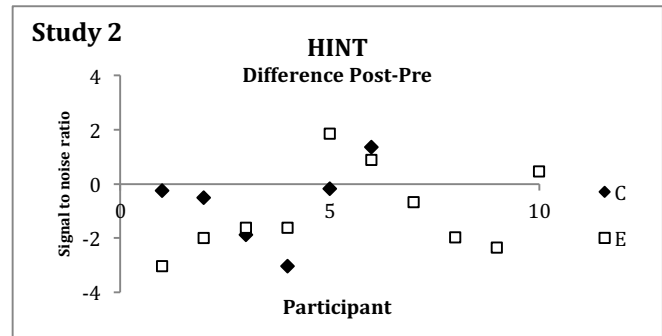
**Figure 1.** Difference of pre- and post-training HINT threshold measured in five participants in the experimental group (E) and five in the control group (C) for study 1.

Results for S2 are different in terms of percentage of participants showing improvement (Figure 2). In fact, 60% of the participants in the experimental group showed a decrease in SNR of at least 1 dB while 33% reached this level in the control group. However, as in S1, the average of the signal to noise ratio decrease was greater in the control group (-2.45) than in the experimental group (-2.1).

The S1 and S2 results suggest that following the listening in noise training program, children with APD are more likely to show improvement in their performance when listening to speech in noise, but with a limited magnitude. The positive changes cannot be attributed only to the benefits of the treatment because children in the control group can reach equal or greater performance compared to the one in the experimental group over time.

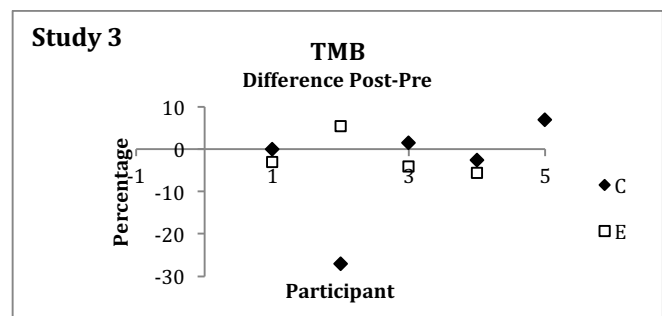
Based on these data, the TMB was used in the experiment with adults to examine if this test could be more sensitive to the effect of noise desensitization therapy on speech in noise test performance than the HINT.

Result of the S3 revealed that one of four adults (25%) in the experimental group and also one in the control group showed an increase of the percentage of correct responses of at least 5% on the TMB (Figure 3). This was an increase of 5.5% and 7% respectively.



**Figure 2.** Difference of pre- and post-training HINT threshold measured in ten participants in the experimental group (E) and six in the control group (C) for study 2.

These preliminary results could suggest that the TMB is not a good test to capture the benefits of this therapy type. However, the fact that the majority of the S3 participants did not fail this test by having a score within normal limits could influence the conclusion. In other words, adults who fail the TMB might be better candidates to show improvement on this test.



**Figure 3.** Difference of pre- and post-training TMB percentage of correct responses measured in four participants in the experimental group (E) and five in the control group (C) for study 3.

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### References

- [1] CSGSLPA. <http://sac-oac.ca/sites/default/files/resources/Canadian-Guidelines-on-Auditory-Processing-Disorder-in-Children-and-Adults-English-2012.pdf>, 2012.
- [2] ASHA. <http://www.asha.org/members/deskref-journals/deskref/default>, 2005.
- [3] Saunders, G. H., et al. (1989). *Ear & Hearing*, 10, 200-208.
- [4] Saunders, G. H., et al. (1992). *Ear & Hearing*, 13, 241-254.
- [5] Maggu, A. R. et al. (2011). *Canadian Journal of Speech-Language Pathology and Audiology*, 35, 56-.
- [6] Loo, J. H, et al. *Ear & Hearing*, 37, 38-47.
- [7] Vallancourt, V. et al. (2008). 29, 453-466.
- [8] Lagacé, J. (2010). *Revue canadienne d'orthophonie et d'audiologie*, 32, 19-30.