SCREENING USING A SPEECH-IN-NOISE 3-DIGIT HEARING TEST BY PHONE: SCORING, RESPONSE TIME, AND AGE

Emilie Vormes[1], Bruno Frachet[1], Vincent Pean[1], Sofie Jansen[2], Jan Wouters[2]

[1] Association France Presbyacousie, Hopital Rothschild, Paris, France
[2] ExpORL, Department Neurosciences, K. U. Leuven, Belgium

Abstract

Background: A screening using a speech in noise test made of digit-triplets by phone has been launched in February 2009 in France. 58,000 calls were made within 2 years.

The results of the screening (good, insufficient, poor) were consistent with previous studies by the test promoter (K.U. Leuven). As this test was mainly designed for seniors, we wanted to know if the results were age-dependent. We decided to study the variations of response time.

Study sample: A random sample of 1,000 calls among 58,000 calls.

Materials and Methods: The callers have been studied for age, response-time, number and sequence of errors. Statistics were made (ANOVA).

Results: Response time increases with age, incorrect answer and low signal/noise ratio. Response time is independent of the group in which belongs the caller (good, insufficient or poor screening results).

Conclusions: The 3-digit test by phone is valid for hearing screening test. We want to match it with the immediate memory tests and cognitive assessments.

Key words: screening speech in noise test • digit triplets • age • response-time

Abbreviations: ANOVA – Analyses of variance; SNR – Signal-to-noise ratio; SRT – Speech reception threshold

Background

HEIN?-Test published as the French Digit Triplet Test (Jansen et al., 2010) is a functional self-test that can be performed by telephone. It was introduced in France on February 2009 and >59,000 people dialed since then. HEIN?-Test is a speech-in-noise screening test that measures the ability to understand speech in noise by determining the signal-to-noise ratio (SNR) that corresponds to 50% intelligibility, with lists of 27 triplets of the digits 1 to 9 presented in a stationary speech-weighted noise. The test discriminates between normal hearing subjects and subjects with SNR loss. The test has a high sensitivity and specificity, 0.91 and 0.93 respectively. Unlike the outcome of questionnaires, the outcome of this test does not depend on the 'perceived' disability. The callers are studied for their age, gender, response-times and global score. An automat gives the caller his (her) score ('good', 'insufficient', 'poor') and counsel for a follow-up.

Materials and Methods

Subjects: randomized sample of 1,147 subjects among 50,000 callers of the Hein?-Test.

Procedures: 27 triplets per call → 30,969 triplets in total.

Per triplet: correct (OK) or incorrect (KO) response, response-time (sec.)

Per call: good, insufficient, or poor

We studied the possible links between age, quality of each answer and each call, and mean response-time.

Results

- *Is the mean response-time linked to the quality of the answer correct/wrong (I.e. is it longer for a wrong answer)?*
- *For all the subjects and all the answers* (Paired Student's t-test: significant difference $p<0.05$), the mean response-time for a wrong answer is on average significantly different (longer) than for a correct answer.
- *For all the subjects and for a given step of the test;* (unpaired Students'-test: significant difference $p<0.05$) same result.
- *Is the mean response-time linked to the subject's age and to his/her global score at the test?*

ANOVA with 2 factors

- Dependent values = averaged response-time 2 factors: age; score at the Hein?-Test ("good", "insufficient", "poor").

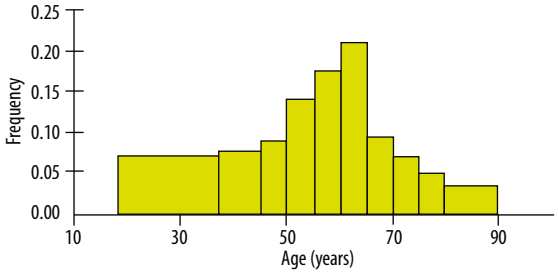

Figure 1. Histogram of ages. Decomposition in order to have enough subjects in each age group.

- **Results: significant effect Age/Score, no interaction effect Age/Score on the mean response-time.**
- Post-hoc tests – Fisher (LSD)
  ✓ *Differences between ages*

The mean response-times increase with age.

✓ *Differences between the groups of scores*

Significant difference between "good" and the other groups: the mean response-time is significantly shorter for "good" subjects than for the others. NO significant difference between "insufficient" and "poor".

- *Is the mean response-time for a correct answer (OK) linked to the age and to the global score at Hein?-Test?*

- 2 factors-ANOVA with repeated measures

Dependent values = **Mean** response-time for a correct (OK) answer Mean response-time for a wrong answer (KO)

2 factors: age; score at the Hein?-Test ("good", "insufficient", "poor").

- **Results: Significant effect Age/Score and no interaction effect Age/Score on the mean response-time.**
  - Response-time OK and Response-time KO (see Table 1)

An age-effect on the mean response-time when the answer is correct (OK) or incorrect (KO).

A global score-effect for the HEIN?-Test on the mean response-time when the answer is correct (OK) or incorrect (KO)

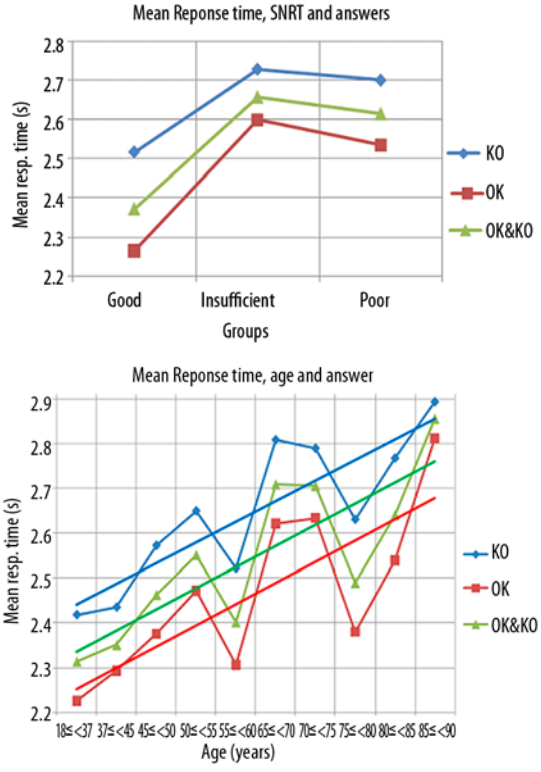

Figure 2. Age effect and score effect on the mean response-time of correct answer (OK), wrong (KO) and all answers (OK and KO).

✓ Post-hoc tests – Fisher (LSD)
- Statistically significant differences between ages
- *Differences between the groups of scores*

Significant difference between "good" and the others: the mean response-time for a correct answer (OK) or an incorrect answer (KO) is significantly shorter for "good" than for others. No significant difference between "insufficient" and "poor".

Conclusions

1. The mean response-time for a wrong answer is significantly different (longer) than for a correct answer. This is true at every step of the test.

Table 1. ANOVA: significant effect Age/ Score, no interaction effect Age/Score on the mean response-time.

Analysis Type III Sum of Squares:					
Source	**DDL**	**Sum of squares**	**Mean of squares**	**F**	**Pr >F**
		OK&KO | OK | KO			
Age	9	19.349 | 20.209 | 17.754	2.150 | 2.245 | 1.973	4.687 | 4.094 | 4.643	<0.0001 | <0.0001| <0.0001
Mean SNRT	2	8.692 | 11.258 |4.948	4.346 | 5.629 | 2.474	9.474 | 10.264 | 5.822	<0.0001 | <0.0001 | 0.003
Age* mean SNRT	18	9.164 | 11.418 | 7.332	0.509 | 0.634 | 0.407	1.110 | 1.157 | 0.959	0.336 | 0.291 | 0.506

2. a). The mean response-time increases with age. b). A global score-effect on mean response-time: The mean response time is significantly lower for the "good" than for others.

No significant difference between "insufficient" and "poor".

3. a). An age-effect on mean response-time when the answer is correct (OK) or wrong (KO): mean response time increases with age. b). A global score effect on mean response time when the answer is correct (OK) or wrong (KO): the mean response-time was significantly lower for the "good" than for others. No significant difference between "insufficient" and "poor".

4. There is a relationship between score and age groups: under 60 y. old are more likely than average to have results "good" and over than 60 y. old are more likely than average to have a result "poor".

Non noteworthy results

Variation of the scores according to age: those results are linked to presbyacusis. Conversely – The Hein-test doesn't consider the dependence on age and the "normal" hearing loss with age: Could this test be of help to differentiate "normal" from early presbyacusis?

Noteworthy results

The variation in response-time for correct and incorrect answers for "good" subjects compared to others. Here was a surprising result because the wrong answers for "good" subjects occur in very unfavorable conditions (low SNR). So the "good" would tend to respond more quickly. **Is this related to cognition-hearing?**

References:

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