Auditory, cognitive and linguistic processing skills in individuals with hearing loss

Shivali A Konganda[1,2], Mridula Sharma[1,2], Jessica JM Monaghan[1], Gitte Keidser[2,3], Joaquin TV Valderrama[1,2,3], John Newall[1], Elizabeth Beach[2,3]

[1] Department of Linguistics, Macquarie University, [2] HEARing Co-operative Research Centre, [3] National Acoustic Laboratories, Australia

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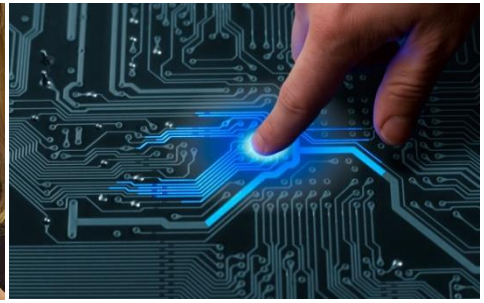


Introduction

- Common reported complaint encountered in adults with hearing loss is speech understanding in the presence of noise.
- May be attributed to peripheral hearing loss

(Stenfelt &Rönnberg, 2009;Abel, Krever, &Alberti,1990)

- Problems persist despite given appropriate amplification

(Plomp, 1978; Kochkin.S, 2010)

The question: is the problem of listening in noise just a result of loss of hearing sensitivity?

What do we know?

Auditory Processing

- Poor temporal processing (frequency modulation, amplitude modulation, TFS-LF) (Emily et al., 2004; Kathryn et al., 2011)
- Poor spectral resolution (spectral ripple noise) (Turner et al., 1999; Henry et al.,2005)

Cognitive Processing

- Poor working memory capacity (Ng et al., 2013; Lunner, 2003)
- Poor selective attention (Shinn-Cunningham & Best, 2008)
- Poor cognitive spare capacity (Mishra at al., 2014)

Linguistic Processing

- Poor phonological processing (Andersson,2002; Lyxell B, Andersson U, Borg E, Ohlsson IS,2003 **)**
- Poor verbal fluency (Classon. E et al., 2014)

Evidence on self reported measure

Self –reported hearing difficulties co-relate with cognitive skills

(Zekveld, et al., 2013; Hoi et al., 2013)

Therefore the **questions** are:

What are the various skills impacted in individuals with hearing loss who complain of speech understanding in the presence of noise?

Aim of the current research

To identify the possible differences on auditory, cognitive and linguistic skills between individuals with hearing loss who complain of speech understanding in noise versus those with normal hearing, no difficulty in speech understanding in noise

Hypothesis

Individuals with hearing loss will show reduced performance on all the tasks, more pronounced in speech understanding in noise task

Method

Participant Candidacy: HL

Participants:
Age range of 18 to 70 years were recruited

Screening tests:
1) Montreal Cognitive Assessment (MoCA)
2) Otoscopy & Tympanometry

Study population:
Individuals with mild-moderate to moderately severe symmetrical sensori neural hearing loss with reported Listening in noise concerns using Speech Spatial and Qualities of hearing scale (SSQ-12)

Method

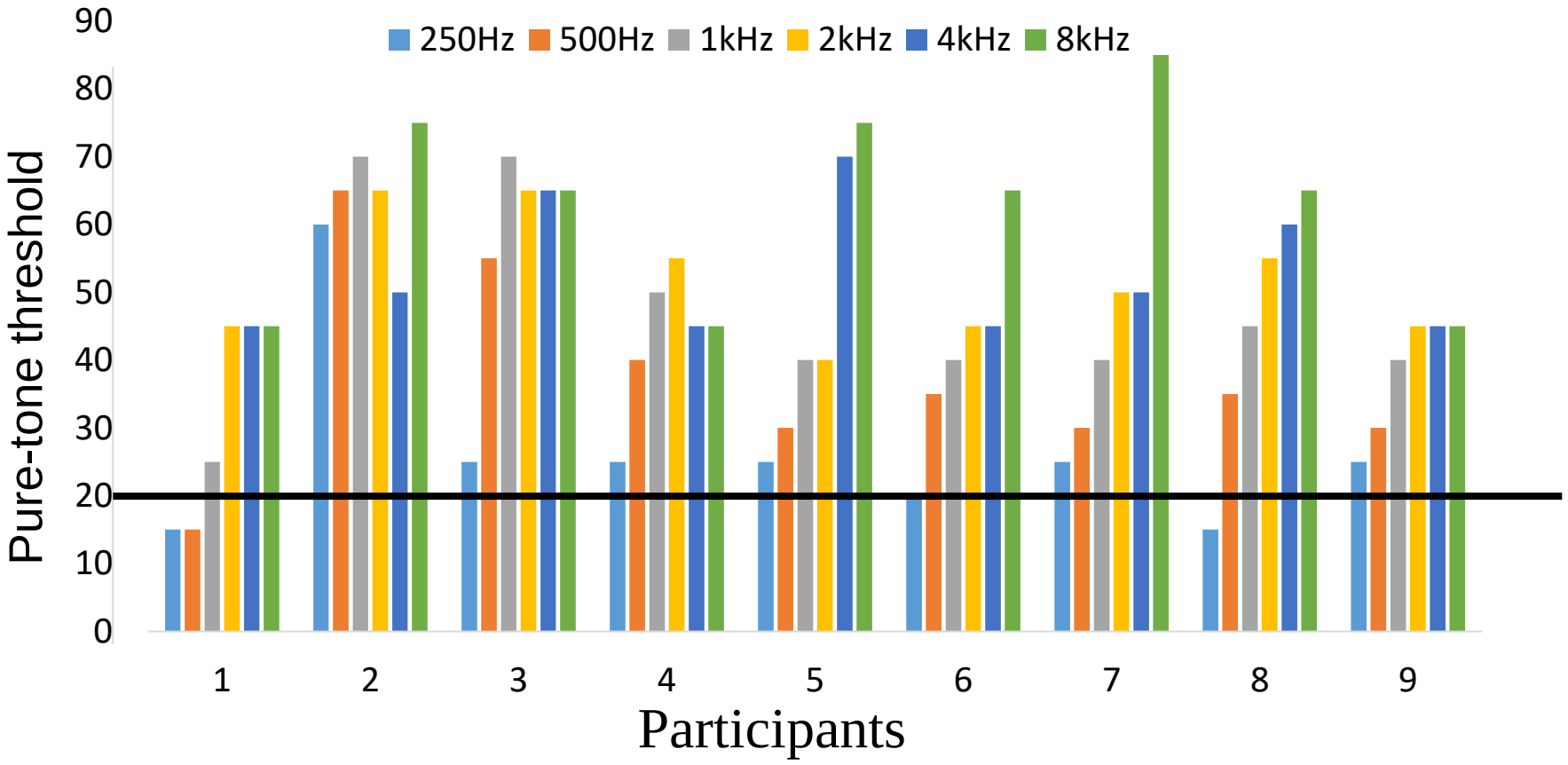
Participant Candidacy: Normal hearing

Participants:
Age range of 18 to 50 years were recruited

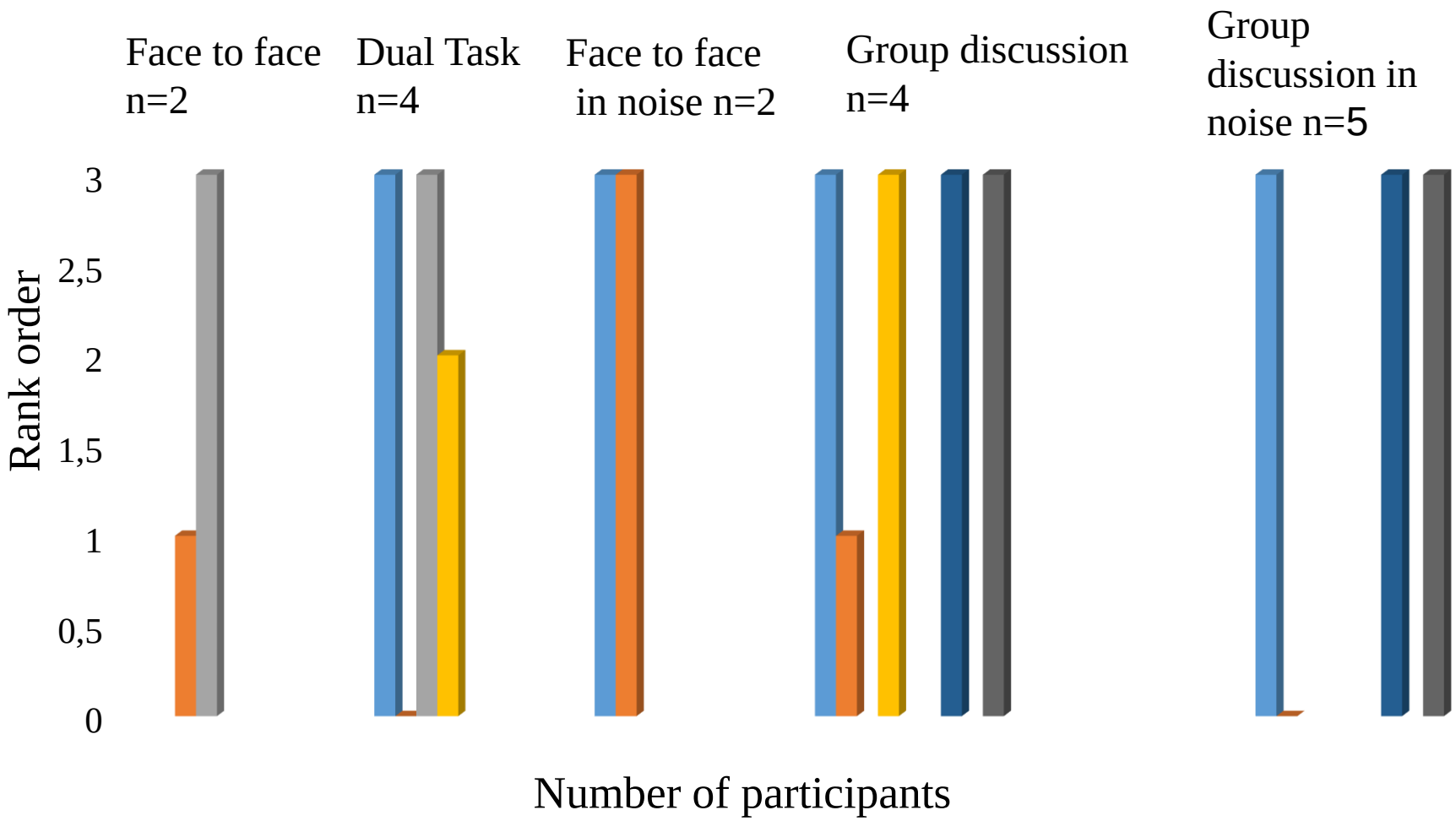
Screening tests:
1) Montreal Cognitive Assessment (MoCA)
2) Otoscopy & Tympanometry

Study population:
Individuals with normal hearing and no reported Listening in noise concerns

Audiograms (n=9)



SSQ-12 (n=9)


Face to face n=2
Dual Task n=4
Face to face in noise n=2
Group discussion n=4
Group discussion in noise n=5
Rank order
3
2,5
2
1,5
1
0,5
0
Number of participants

Test battery

Independent variables	Outcome measures
Auditory tasks	NAL-Dynamic conversations test (DCT)
Cognitive tasks	Speech recognition threshold assessed Beautifully Efficient Speech Test (BEST sentences) (SRT)

Tests

Auditory tests	Description
Iterated ripple noise (IRN)	Temporal pitch processing ability
Spectral-temporally modulated ripple test (SMRT)	Spectral resolution
Modulation detection threshold (MDT)	The temporal envelope information
Pitch discrimination (PD)	Spectral resolution

Cognitive tests	Description
Digit span test (Forward and backward)	Short term and working memory
Auditory & visual (aSL & vSL)	Ability to identify statistical regularities implicitly
Cognitive spare capacity test (CSCT)	Uptake, inhibition control, memory, when listening to series of numbers in noise
Attention	Selective attention and attention switching

Linguistic tests	Description
Auditory rhyme judgement test	Phonological processing
Visual rhyme judgement test	Phonological processing

Stimuli Presentation

- All participants were experienced hearing aid users, used at least for 6 months
- All auditory stimuli presented using NAL-RP gain, bilateral presentation
- All cognitive and linguistic tests presented through same make hearing aids with NAL-RP gain and based real ear measurement

Analysis

Number of Participants

Normal hearing: 9, age 18-50 years (8 females)

Hearing loss: 9, age 18-70 years (7 females)

Parametric test

- Multi-variate analysis of Variance (MANOVA) was carried out
- Age used as co-variate

Results

Group effects:

- MDT

[F (1, 15) = 3.24, p =0.04]

- CSCT

[F (1, 15) = 4.72, p= 0.04]

- SRT

[F (1, 15) = 25.6, p<0.001]

– **Significant(p<0.05)**

To evaluate significant differences

Individual data : Standardization was carried out for all the tasks

Calculating the Standard Score (Z-Score)

$$\text{Standard Score, } z = \frac{X - \mu}{\sigma}$$

TERMS:

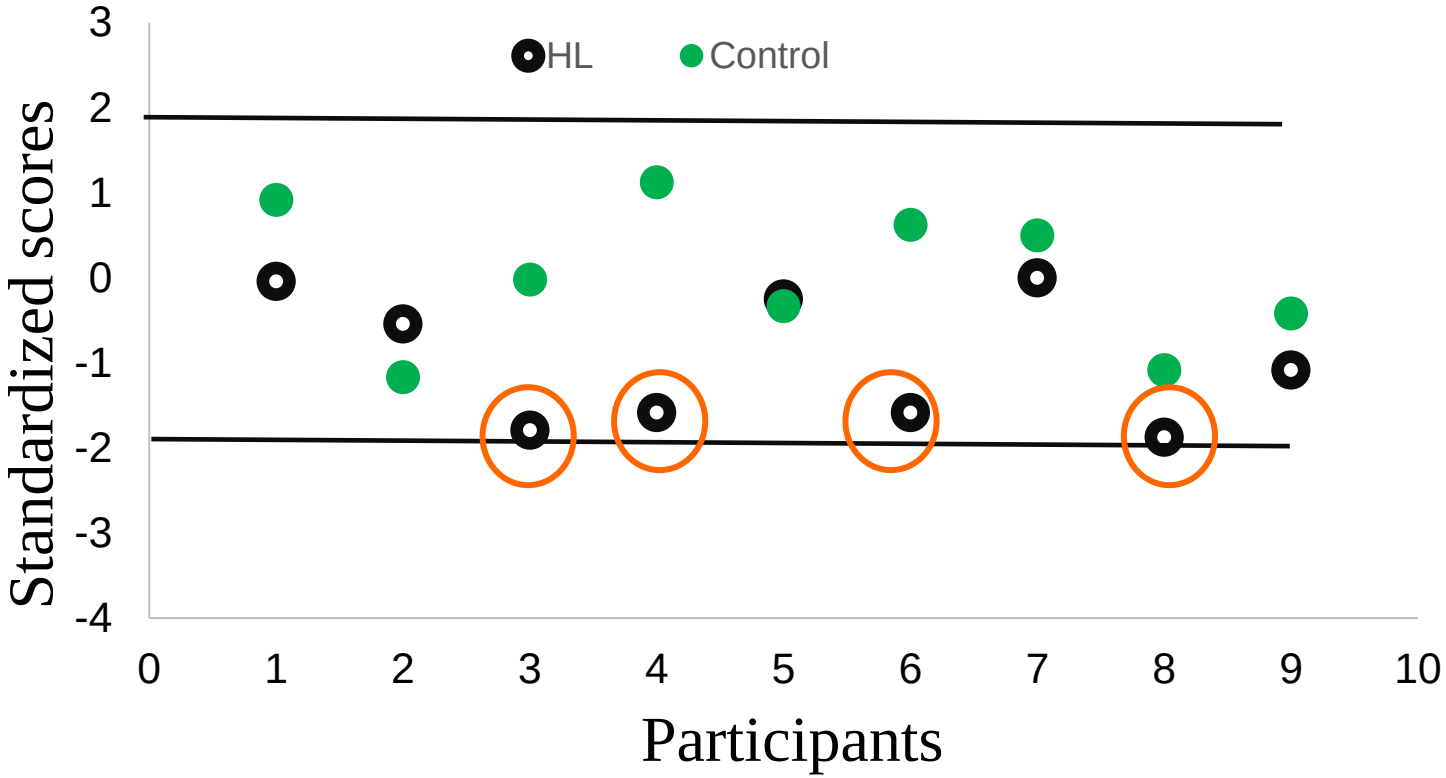
μ = mean (pronounced 'mu')

X = score

σ = standard deviation (pronounced 'sigma')

(another 13 control group was used to perform standardisation, Mean 31.2 yrs and Median 29.5)

Auditory test: MDT



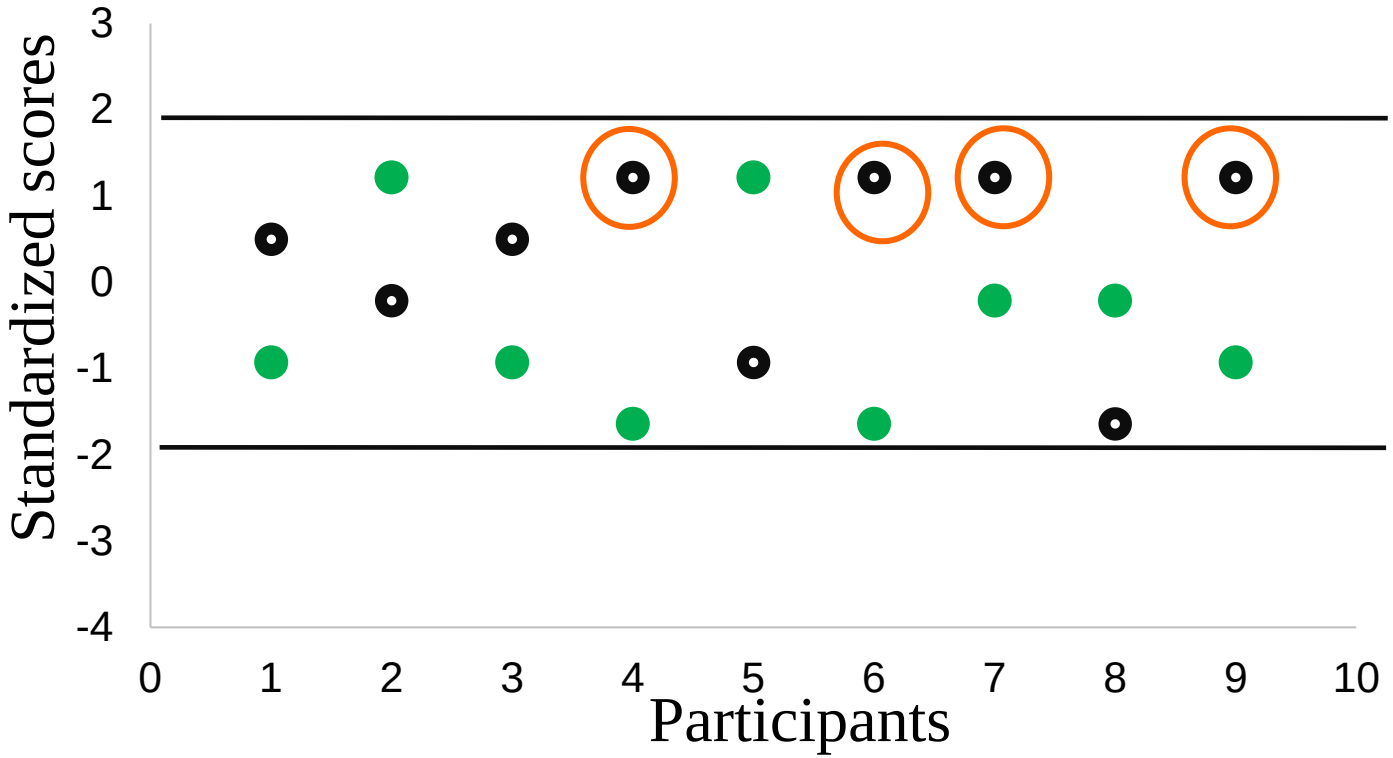
Poor performance

Good performance

Contrasting results (Feng, Yin, Kiefte, & Wang, 2010; Grant, Summers, & Leek, 1998)

Consistent with previous research (Bacon & Gleitman, 1992; Tandetnik, Garnier, & Lorenzi, 2001)

Cognitive Spare capacity test

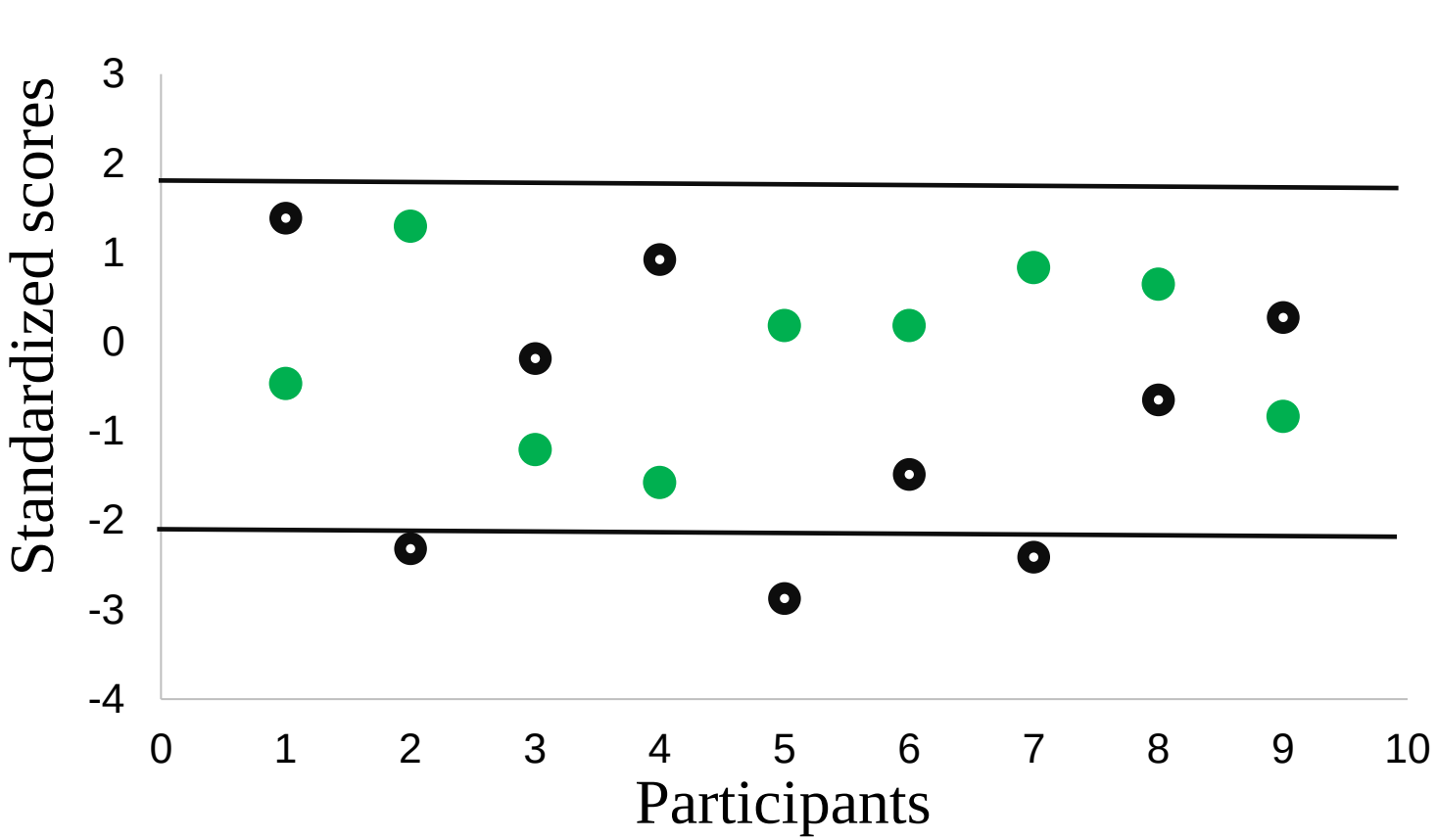


Good performance

Poor performance

(Keidser, Best, Freeston, & Boyce, 2015; Mishra, Stenfelt, Lunner, Rönnberg, & Rudner, 2014)

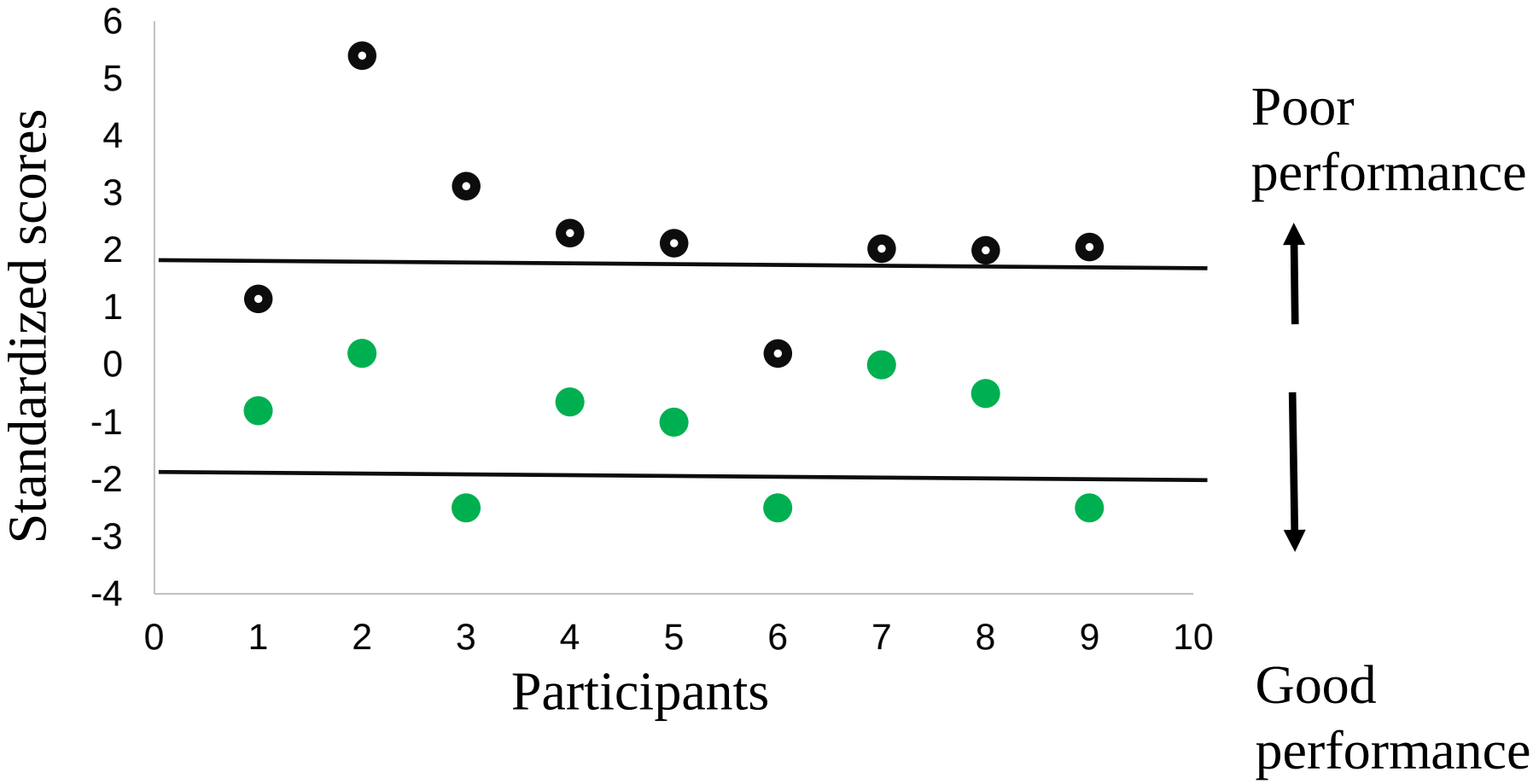
NAL-DCT



Good performance

Poor performance

SRT


Standardized scores
6
5
4
3
2
1
0
-1
-2
-3
-4
0
1
2
3
4
5
6
7
8
9
10
Participants
Poor performance
Good performance

Discussion

Why did we not see a significant difference on auditory processing tasks?

- Adults with HL may be compensating for hearing related difficulties
- Amount of amplification is appropriate and therefore the performance is at ceiling

(Ng et al., 2013; Lunner, 2003)

- Or could it be that the applied tests are not sensitive to evaluate the participants' skills

Why did we not see a difference on NAL DCT (speech understanding in noise), especially as most performed poorly on SRT (recognition) at the same level?

- Speech understanding in noise relies on interaction between cognitive and auditory processing

  (CHABA, 1988, Pichora-Fuller, Schneider, & Daneman 1995; Humes, 2007)

- Speech recognition may be affected as there is reduced contextual information
- Perhaps other auditory processing skills need to be evaluated maybe stream segregation skills

Future direction

- Implement more realistic based scenario tests that could possibly answer this question

- Elaborate more on the self-reported questionnaire information

Acknowledgements

I thank all my participants for their time and effort
and all my supervisors for their support and guidance