Measures of Cognitive Ability in Listeners with Self-Reported Hearing Difficulties but Normal Audiograms

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Introduction

With renewed interest in hearing difficulties that might not be detectable using standard audiometric testing, there is a need for new measures that might be sensitive to common self-reports of hearing difficulties, such as difficulties in understanding speech in complex listening situations with noise or reverberation. Given that links between cognitive function and speech understanding, particularly in challenging situations, are well known (Rönnberg et al., 2010), we reasoned that it is important to characterize the cognitive function of a sample of listeners that potentially suffer from hidden hearing loss. We were interested in processing speed, working memory and executive function and how those categories relate to self-reported hearing difficulties, despite normal audiometric thresholds. Processing speed is the rate that a cognitive task can be performed with reasonable accuracy (Salthouse, 1996). Working memory is a cognitive system responsible for processing and temporary storage of information during complex cognitive tasks (Baddeley, 1992). Executive function coordinates many mental operations necessary for completing a complex cognitive task including allocating working memory resources, shifting attention, inhibiting, and updating information (Miyake et al., 2000). Hearing loss, speech perception and cognition have well-established connections (Humes & Young, 2016) but at this time the connections between hidden hearing loss and cognition have not been defined. The objective of this study was to determine whether there is a relationship between cognitive measures and self-reported hearing difficulty in a sample of listeners with normal audiograms.

Methods

SUBJECTS

26 participants were recruited and ranged in age from 18-53 years. All participants had normal audiograms (≤20 dB HL from 250 to 8000 Hz, 1 subject ≤25 dB HL) and self-reported difficulty hearing, which was the purpose of their visit to the Heuser Hearing Clinic.

TESTS

1. Trail Making Tests (TMT) A and B (Reitan, 1958; Bowie & Harvey, 2006)

- TMT measures visual search, scanning, processing speed, mental flexibility and executive functions.
- TMT-A requires participants to draw a line connecting 25 numbered circles randomly distributed on a paper, in sequential order (e.g. 1, 2, 3...)
  - Primarily taxes visual search and processing speed.
- TMT-B requires participants to draw a line connecting circles alternating between numbers and letters in sequential order (e.g. 1, A, 2, B, 3...)
  - Taxes executive function for the set switching in addition to processes required for TMT-A.

PROCEDURE:

- Participants were instructed to complete each part of the TMT as quickly and accurately as possible. Participants were scored by the total time it took to complete each trail.

2. Digit Span Forward and Backward

- Digit Span Forward is thought to measure memory capacity, and backward span is thought to measure both memory capacity and working memory.

PROCEDURE:

- The examiner read a set of numbers (one number per second) and the participant was asked to verbally recite the numbers in forward or reverse order.
- Span lengths ranged from 2 to 9 digits, and there were two sets of numbers per span length. Testing ended when the participant was incorrect on both sets of numbers for a given span length, and the previous span length was recorded as their score.

Results

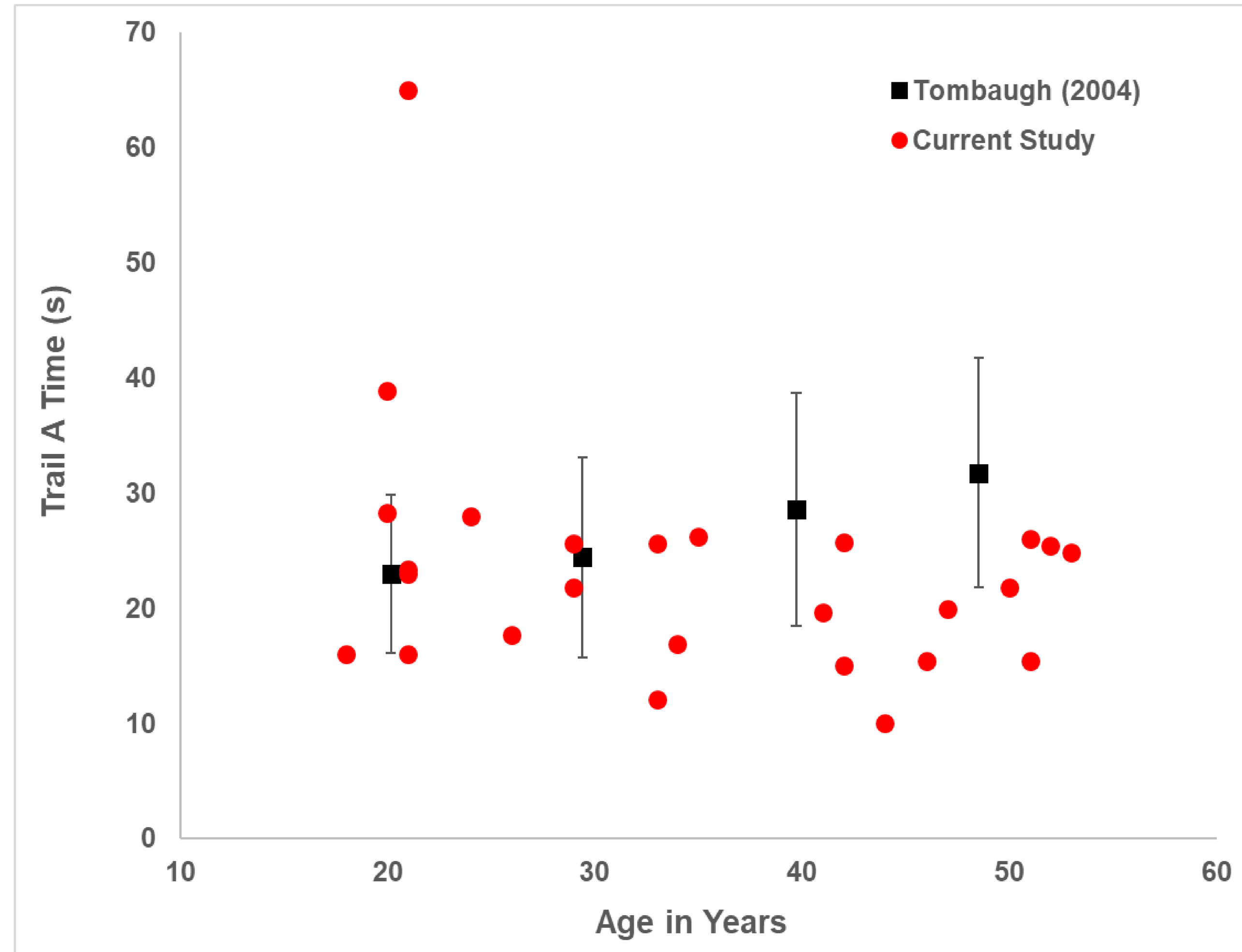

Figure 1

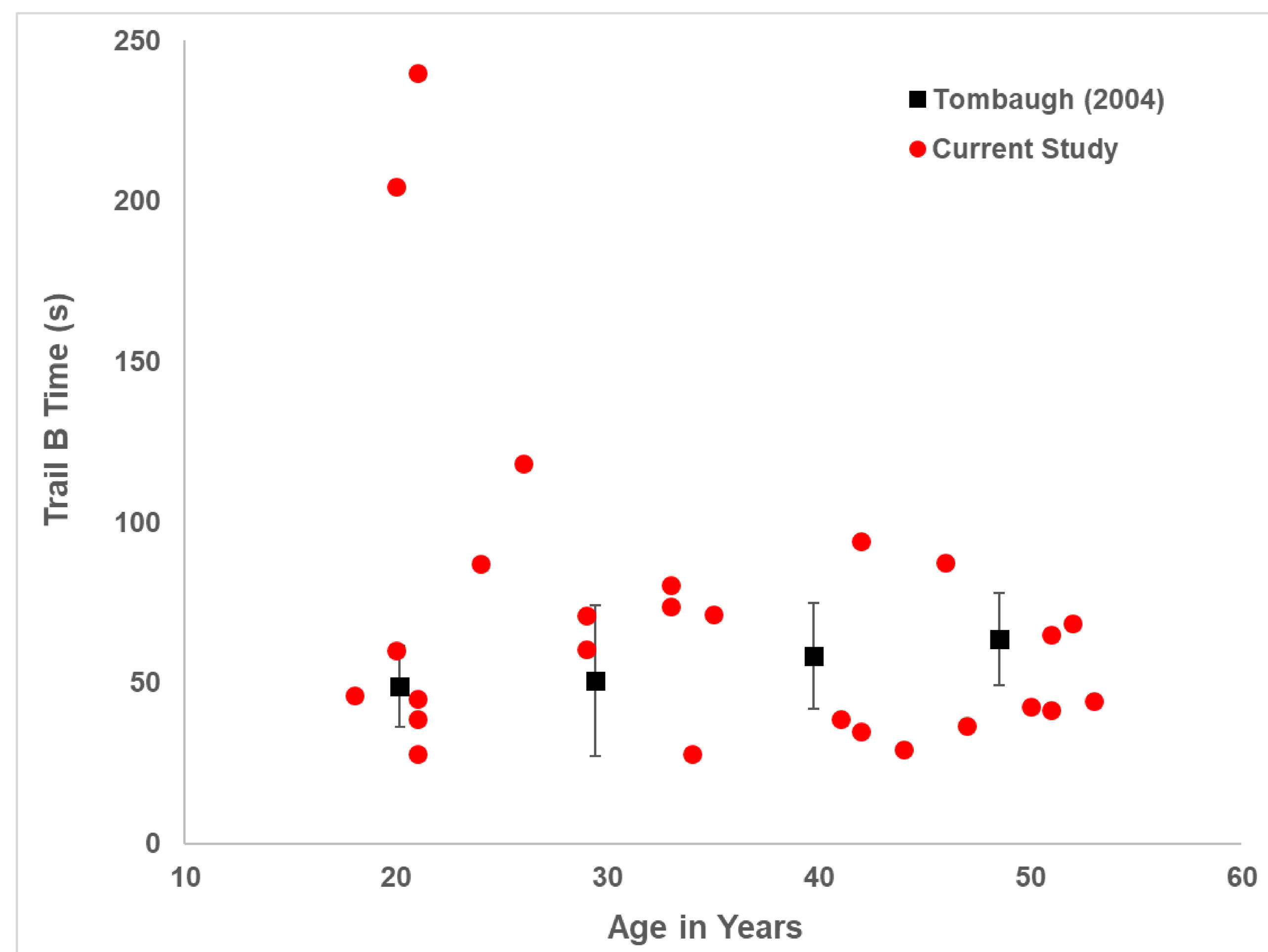

Figure 2

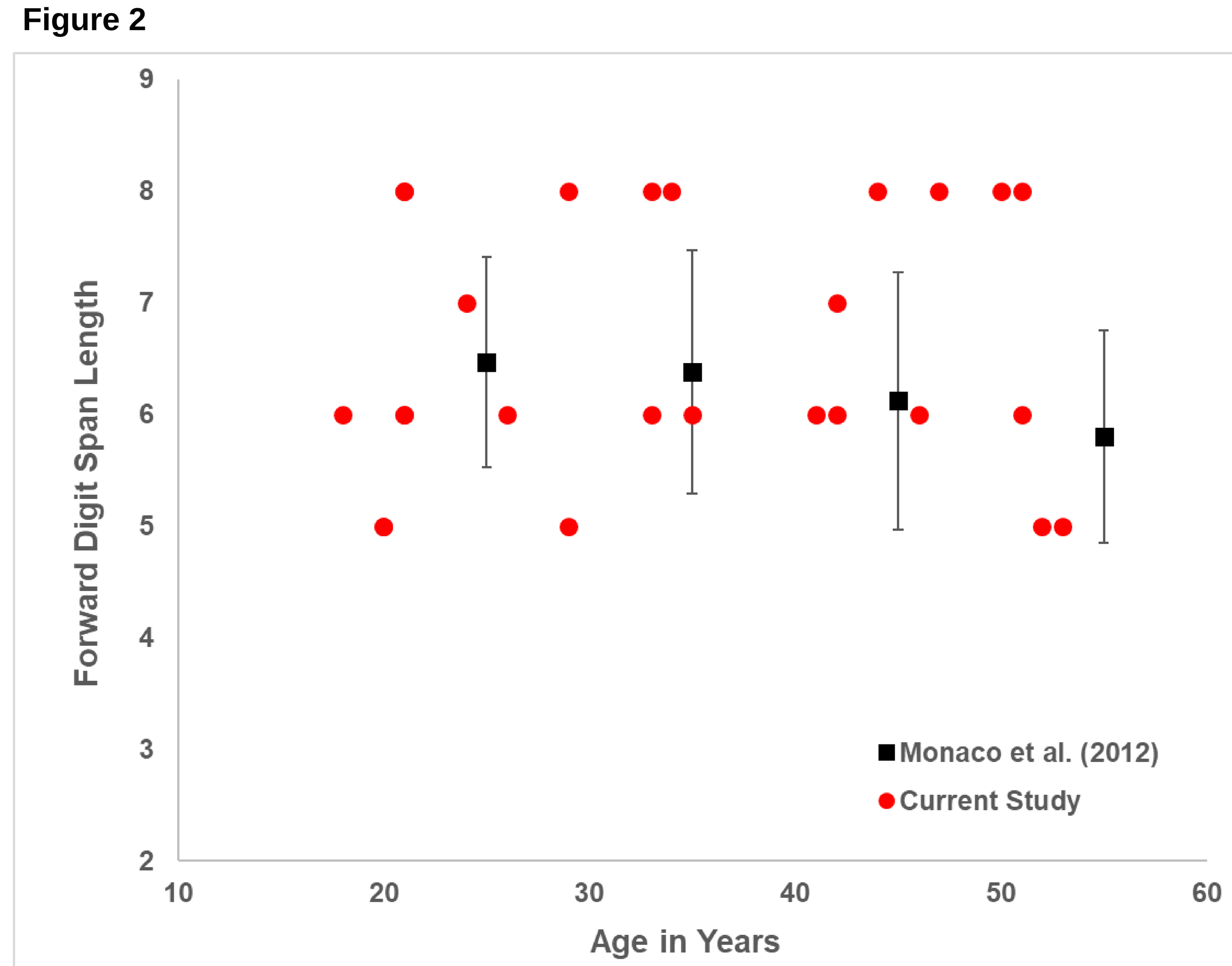

Figure 3

Figures 1 & 2. Scatter plots for the time to complete Trail Making A and Trail Making B (*n* = 26) compared to Tombaugh's (2004) aged-matched normative data (mean ±1 SD). Normative data age ranges: 25-34, 35-44, 45-54, and 55-59 years.

Figures 3 & 4. Scatter plots of Forward Digit Span length and Backward Digit Span length (*n* = 26) compared to Monaco et al. (2012) aged-matched normative data (mean ±1 SD). Normative data age ranges: 20-30, 31-40, 41-50, and 51-60 years.

Poster available online:

Results

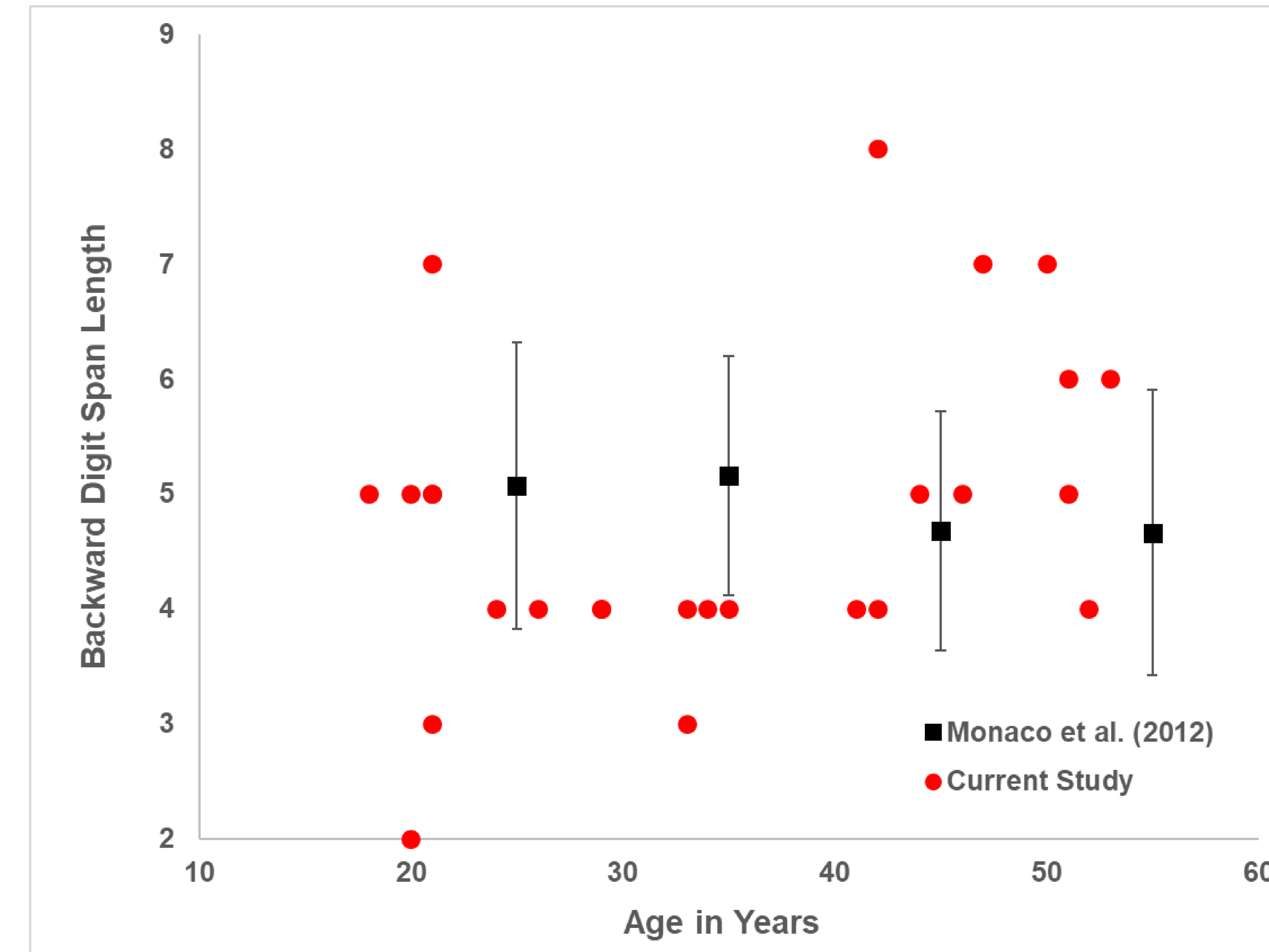

Figure 4

Our population with self-reported hearing difficulties was not significantly different from normative data for tests assessing processing speed (Trail Making A, p = .262) working memory (Digit Span Forward, p = .090; Digit Span Backward, p = .608), and executive function (Trail Making B with outliers trimmed, p = .122). These results suggest that cognition is likely not a contributing factor to self- reported hearing difficulties for our audiometrically normal sample.

Conclusions

The data presented here are part of a larger study with a population that has confirmed speech perception in competing speech difficulties (see poster PP1329) and significant self-reported hearing difficulties (see poster PP1312). The results on our cognitive tests were similar to norms suggesting that cognition is likely not contributing to the significant objective (PP1329) and subjective (PP1312) deficits in speech perception within our study sample.

Acknowledgements

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References

Bowie, C. R., & Harvey, P. D. (2006). Administration and interpretation of the Trail Making Test. *Nature Protocols, 1*(5), 2277-2281.
Humes, L. E., & Young, L. A. (2016). Sensory-cognitive interactions in older adults. *Ear and Hearing, 37*(Suppl 1), 52S-61S.
Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*(1), 49-100.
Monaco, M., Costa, A., Caltagirone, C., & Carlesimo, G. A. (2013). Forward and backward span for verbal and visuo-spatial data: standardization and normative data from an Italian adult population. *Neurological Sciences*, *34*(5), 749-754.
Neher T. (2014). Relating hearing loss and executive functions to hearing aid users' preference for, and speech recognition with, different combinations of binaural noise reduction and microphone directionality. *Frontiers in Neuroscience*, *8*, 391.
Reitan, R. M. (1958). Validity of the Trail Making Test as an indicator of organic brain damage. *Perceptual and Motor Skills, 8*(3), 271-276.
Rönnberg, J., Rudner, M., Lunner, T., & Zekveld, A. A. (2010). When cognition kicks in: Working memory and speech understanding in noise. *Noise and Health, 12*(49), 263-269.
Salthouse, T. A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological Review, 103*(3), 403-428.
Tombaugh, T. N. (2004). Trail Making Test A and B: normative data stratified by age and education. *Archives of clinical neuropsychology*, *19*(2), 203-214.