May 18th, 12:00 AM - May 22nd, 12:00 AM

Feasibility of Psychoacoustic Testing on Hearing-Impaired Individuals with a Portable Device

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Introduction

- Portable Automated Rapid Testing (PART) was developed at the University of California, Riverside Brain Game Center
- PART expands on a traditional hearing test by measuring individuals' auditory processing abilities.
- PART also features an untraditional method of testing by conducting the testing on a portable device
- Lelo de Larrea-Mancera and colleagues (2020) established PART normative data from 150 undergraduate students at the University of California Riverside (Data was collected before 2020)
- This study aims to evaluate PART's feasibility in the mild-to-moderate hearing-impaired population.

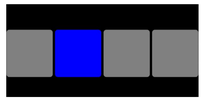
Methodology

- Participants
  - Normal hearing (NH) subjects (n = 9, mean age = 21, SD = 2.5)
  - Hearing impaired (HI) subjects (n = 8, mean age = 65, SD= 12.5)

  Eligibility
    - MoCA score 26 or higher (out of 30)
    - Confirm the health of the outer & middle ear status
    - Pure-tone audiometry testing configuration and thresholds
      - HI subjects: mild-to-moderate symmetrical Sensorineural Hearing Loss
- Equipment
  - PART calibration at National Center for Rehabilitative Auditory Research (NCRAR) in Portland, OR.
  - iPad and Sennheiser 280 Pro headphones calibration: Brüel & Kjær Head and Torso Simulator
  - Sound resistant booth using a GSI 61 audiometer and ER-3 insert headphones
  - Tympanometry testing: Grason-Stadler (GSI) tympstar
- Procedure

  Psychoacoustic tests measured:

  2 kHz Notch Noise, Diotic Frequency Modulation, Dichotic Frequency Modulation, Temporal Gap Detection, Spectral, Temporal, and Spectrotemporal Modulation, and Spatial Release from Masking.
  - Test stimuli presentation: an adaptive Two down/one-up procedure
  - "4 interval 2 alternative forced choice" (4I2AFC) method was used for subject's target selection



Results

Figure 1

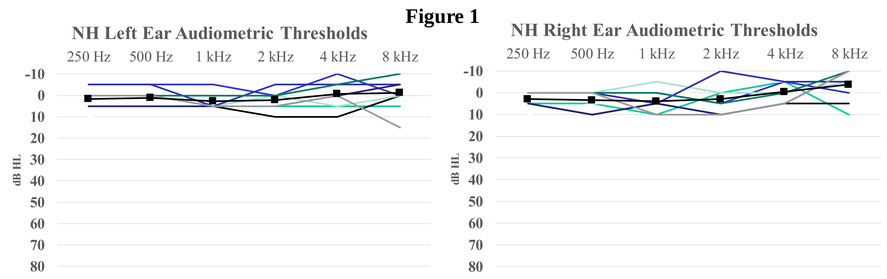


Figure 2

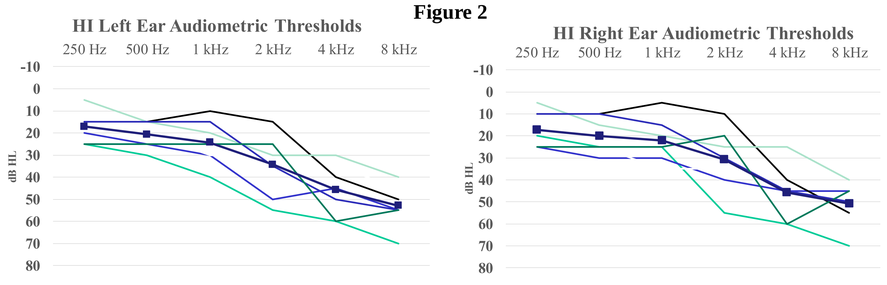


Figure 3

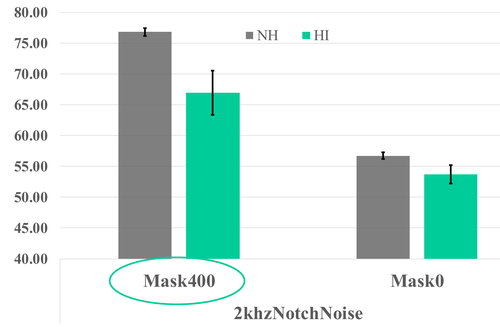


Figure 4

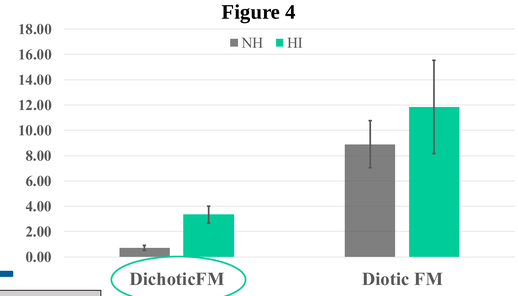
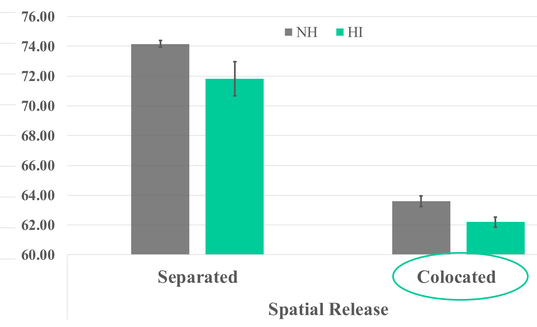


Figure 5



Subject	2 kHz Notch Noise		Dichotic FM	Gap	Diotic FM	Spatial Release		Spectral Temporal Modulations		
Lelo de Larrea-Mancera et al.,(2020)	Mask 400	Mask 0				Separated	Co-located	Temporal	Spectral	Spectral Temporal
NH mean (n=150)	75.98	56.63	0.87	2.51	8.09	69.34	63.48	1.59	1.71	1.18
Standard Deviation	7.88	2.57	1.25	2.9	7.96	3.49	2.83	1.08	1.12	1.03
Subject	2 kHz Notch Noise		Dichotic FM	Gap	Diotic FM	Spatial Release		Spectral Temporal Modulations		
	Mask 400	Mask 0				Separated	Co-located	Temporal	Spectral	Spectral Temporal
NH mean (n=9)	76.81	56.74	0.71	2.42	8.90	74.17	63.61	1.89	1.29	0.86
Standard Deviation	1.97	1.57	0.59	1.68	5.51	0.71	1.08	1.13	0.48	0.34
Standard Error of the Mean	0.66	0.52	0.20	0.56	1.84	0.24	0.36	0.38	0.16	0.11
Subject	2 kHz Notch Noise		Dichotic FM	Gap	Diotic FM	Spatial Release		Spectral Temporal Modulations		
	Mask 400	Mask 0				Separated	Co-located	Temporal	Spectral	Spectral Temporal
HI mean (n=8)	66.95	53.71	3.34	2.81	11.86	71.81	62.19	2.10	1.78	1.52
Standard Deviation	9.41	3.94	1.93	2.33	10.43	3.25	0.96	1.23	0.89	1.08
Standard Error of the Mean	3.56	1.49	0.68	0.82	3.69	1.15	0.34	0.44	0.32	0.38

Table 1. Lelo de Larrea-Mancera et al. (2020) NH participants' data were added in this table as a comparison with data from this study. NH and HI subject groups' mean tests' results were indicated subsequently.

- These findings suggest that it is feasible to evaluate psychoacoustical tests using PART on a population with mild-to-moderate Hearing Loss
- Significant differences were found in 2 kHz Notch Noise (Mask400) testing $t(6)=2.73$, ($p=0.034 < 0.05$), Dichotic FM testing $t(8)=-3.70$, ($p=0.006 < 0.05$), and Co-located SRM testing $t(15)=2.87$, ($p=0.012 < 0.05$).

Discussion/Future Directions

- PART has great potential for contributing to the field of clinical audiology practice by providing a fast, easy, and affordable addition to the current test battery
- Significant differences found across groups can be valuable for future research.
- The implications of the app itself may further contribute to future research in hearing aids fitting where spectral and temporal processing ability is not currently considered.
- Due to the COVID-19 pandemic, some participants were not able to complete PART testing. Therefore, our findings are recommended to be re-tested for confirmation of the results in larger scale studies.

Acknowledgements

I am indebted to Western Washington University Research Department for supporting my Honor's capstone project by funding for this research study. I am grateful for Dr. Diedesch's initial consent of me writing a summary of this research project that was led by her and her colleagues. Especially, her long-term guidance and encouragement were indispensable to the completion of this paper. I want to thank Destinee Halverson and Makayla Dordan for giving me a lot of helpful feedback on the paper's editing and revision. I also thank Grace Young and Jess Mendiola who volunteered to collect participants' data at the research lab. Lastly but most importantly, I want to thank all the research participants (some were my friends) for contributing their valuable time to the data collection. Their support was crucial in keeping the research running.

References

Pictures were retrieved from:
https://braingamecenter.ucr.edu/games/p-a-r-t/

Lelo de Larrea-Mancera, E.S., Stavropoulos, T., Hoover, E.C., Eddins, D.A., Gallun, F.J., & Seitz, A.R. (2020). Portable Automated Rapid Testing (PART) for auditory research: Validation in a normal hearing population. bioRxiv. https://doi.org/10.1101/2020.01.08.899088