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INTRODUCTION

- For normal hearing listeners, a small right ear advantage (EA) is typically observed in a dichotic digits task (see Fig 1).
- The right EA may have an anatomical explanation (see Fig 2), but variations in EA can occur in the dichotic digits task results, which means that:
 1. the task may not be sensitive enough to measure a stable EA; or
 2. the right-EA is not due to anatomical asymmetry [1].
- Although EAs may be difficult to detect consistently with percent correct scores on the dichotic digits task, it might be revealed in terms of an asymmetry in listening effort.
- Pupil dilation can show subtle changes in listening effort [3,4,5], and provides a way to study the time course of the EA.

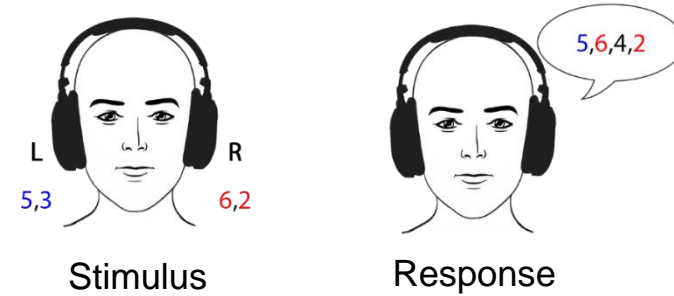


Figure 1. In a dichotic digits task, listeners are presented with a pair of digits in both ears, simultaneously. They respond by recalling all digits they hear in any order.

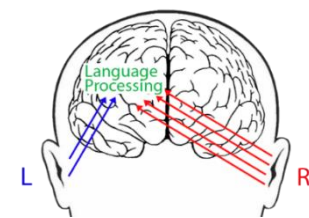


Figure 2. One hypothesis for a right ear advantage is that the right ear may have stronger neural connections to the language processing centers located in the left cerebral hemisphere, compared to the left ear [1,2].

RESULTS

- In the dichotic digits task, most subjects showed less than 3% difference in accuracy scores between ears (Fig. 5).
- In the Left 2/Right 2 and Left 4/Right 4 conditions, more subjects showed an EA, but not necessarily a right-EA (Fig. 5).
- On average, the amount of pupil dilation was different for each condition during the time between the end of stimulus presentation and the response period (Fig. 6).
- Largest amount of pupil dilation (more effort) is seen when recalling digits from both ears (green). For most subjects, more pupil dilation is observed when attending to the left ear vs the right ear, especially in the recall Left 4/Right 4 conditions (Fig. 6).
- Using maximum pupil dilation after stimulus offset as a metric for determining an EA (Fig. 7a), 33% of subjects showed a right-EA and 43% of subjects showed a left-EA in the recall Left 2/Right 2 conditions. Similar proportions of right- and left-EAs were revealed in both visits, but EAs were not consistent within subject.
- In the recall Left 4/Right 4 conditions, 57% showed a right-EA and 19% showed a left-EA (visit 1). 33% of subjects showed a consistent EA across visit in the recall Left 4/Right 4 conditions (Fig. 7a).
- Using mean pupil dilation after response prompt as a metric for determining an EA (Fig. 7b), EAs were more consistent in the recall Left 4/Right 4 conditions (38%), with most subjects demonstrating a right-EA.

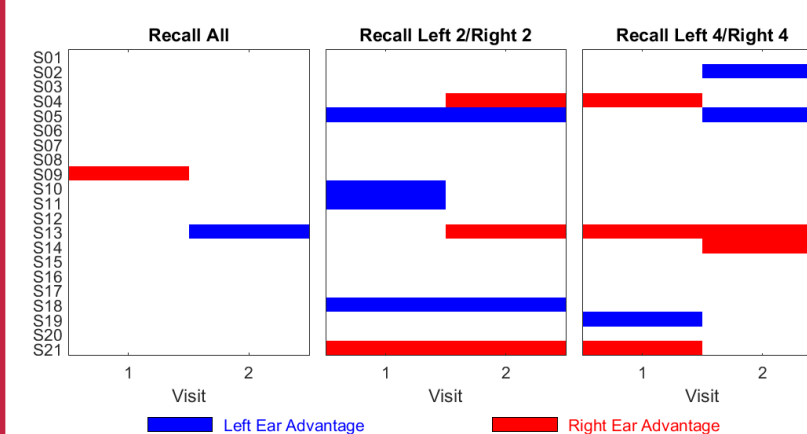


Figure 5. EA from accuracy scores. An EA here is identified when the difference in percent correct between the ears was greater than 3% (two or more digit difference).

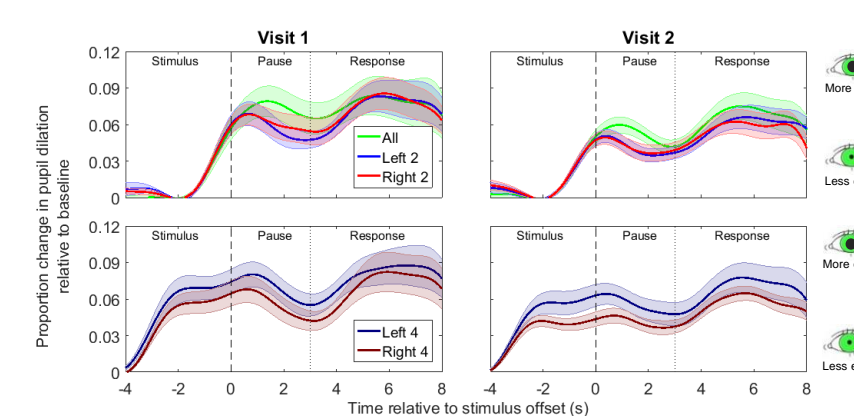


Figure 6. Group-averaged pupil dilation. The dashed and dotted lines indicate stimulus offset, and response prompt, respectively.

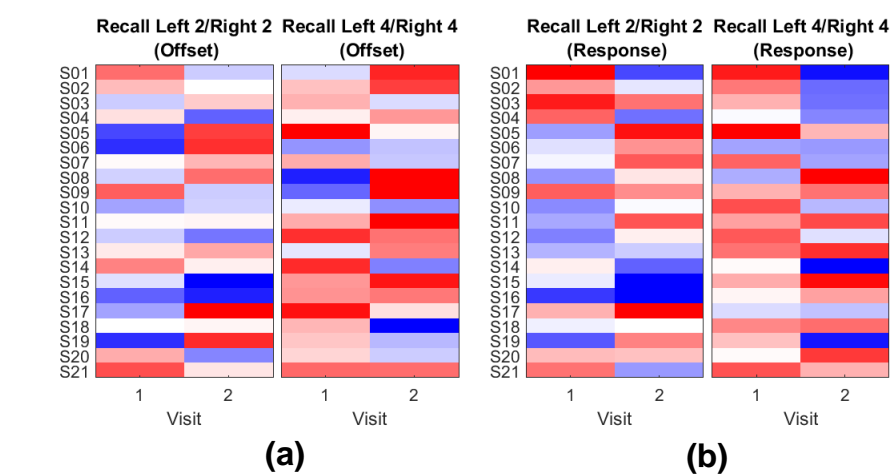


Figure 7. EA revealed by pupil dilation during the period (a) two seconds after stimulus offset, and (b) two seconds after response prompt. Blue and red correspond to left- and right-EA, respectively, and shading is related to the log-ratio of recall left to recall right pupil response.

CONCLUSIONS

- When listening dichotically, attending to the right ear typically required less effort, even when accuracy scores are similar.
- The right-ear advantage for lower listening effort is more pronounced for more difficult tasks.
- Pupillometry may be more sensitive than accuracy scores for measuring an ear advantage.

REFERENCES

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The aim of this study is to determine whether pupillary response will provide a more sensitive method for establishing the presence of an ear advantage.

METHODS

- **PARTICIPANTS:** Twenty-one normal hearing listeners were screened based on pure-tone averages (PTAs) computed from hearing thresholds at 500, 1000 and 2000 Hz in each ear. All listeners had less than 7.5 dB difference in PTAs across the ears.
- **PROCEDURE:** Listeners completed a dichotic digits task for the conditions shown in Fig 3. Pupil dilation data was recorded in each trial (see Fig 4) and averaged for each condition.
- **RELIABILITY:** Each listener was tested twice, with at least one week between visits.

Condition:	Description:	L	R
Left 2	Recall left 2 digits	8,1	5,6
Right 2	Recall right 2 digits	3,6	9,8
Left 4	Recall left 4 digits	2,6,1,4	8,3,9,5
Right 4	Recall right 4 digits	2,9,8,1	3,6,5,4
Both	Recall all digits	5,3	6,2

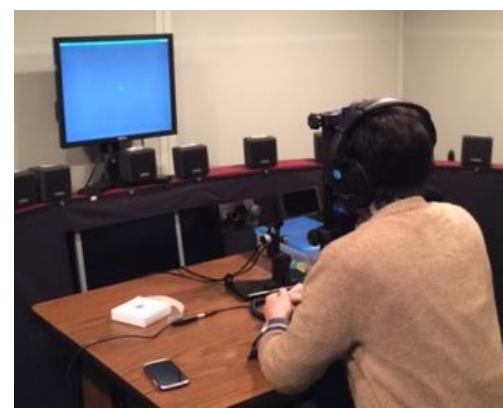
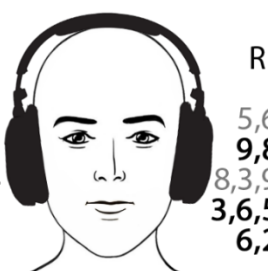


Figure 3. Test Conditions. Listeners were instructed prior to stimulus presentation to verbally repeat either just the left ear digits, right ear digits, or all presented digits (shown in bold type). Sequence of digits were generated randomly for each trial, and each condition was tested 20 times.

Figure 4. Dichotic digits were presented at 57 dB SPL through headphones (Sennheiser HD-280) to the left and right ears, simultaneously. During the task, pupil diameter was measured using an eye tracker (SR Research Eyelink 1000 Plus).