Robust perceptual learning of noise-vocoded speech under divided attention: A dual-task paradigm

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Background

- Humans can adapt speech perception over time [1].
- Existing studies [2-3] point to a key role of **attention in perceptual learning** of degraded speech.
- Learning was absent for unattended speech [3].
- It is unclear if and how perceptual learning is a function of available attentional resources.

Hypotheses

- Perceptual learning is robust under divided attention if learning does not deteriorate under more limited attention.
- Perceptual learning is dependent on attention if learning exacerbates as attention gets restricted.

Methods

- Participants: 192 British-English speakers on Prolific.
- Stimuli:
  - ✓ Six-band noise-vocoded BKB sentences (scan to hear).
  - ✓ Gabor patches with different orientations (Fig. 1).
- Task (between-group design on Gorilla, N=48 per **condition**):
  - ✓ **Control**: Participants recognized and reported back sentences.
  - ✓ **Dual-task**: Recognizing a sentence while deciding the angle of a Gabor patch—either a target (45°) or a non-target.
  - ✓ *Task difficulty* was manipulated by the range of divergence in orientation between the non-target and target: (0°, 12°] apart from the target (*dual easy*), (24°, 36°] (*dual intermediate*), (48°, 60°] (*dual hard*).
- Analysis: generalized additive mixed-effect models (GAMM).

Figure 1. Examples of target (45°) and non-target Gabor patches.

Results

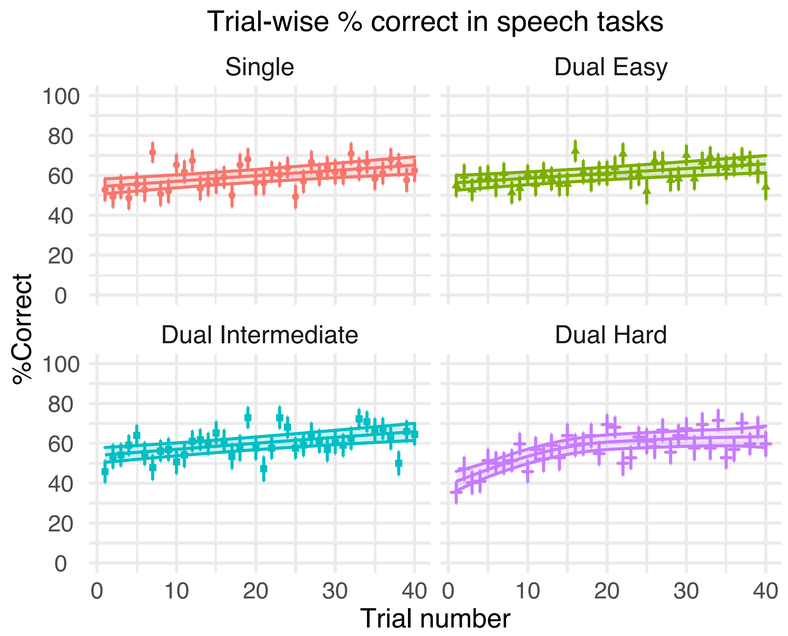

Figure 2. GAMM predictions of speech task performance (% correct).

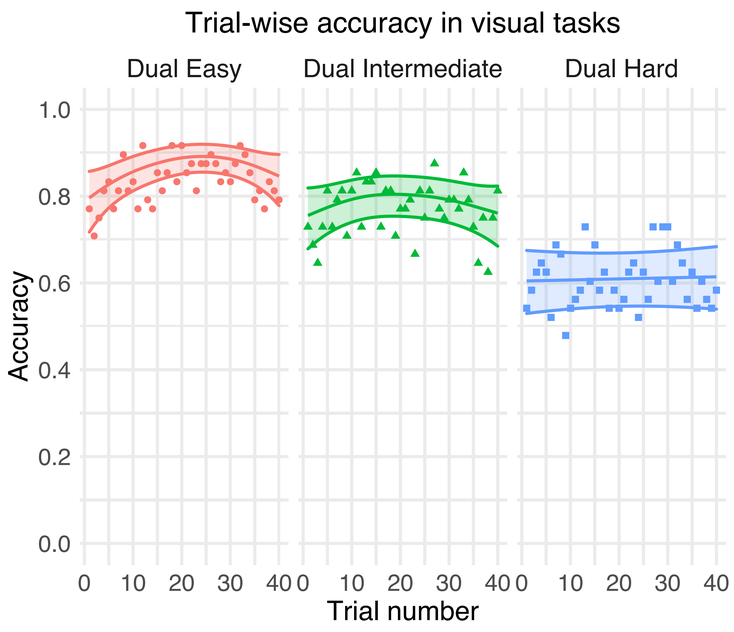

Figure 4. GAMM predictions of visual task accuracy.

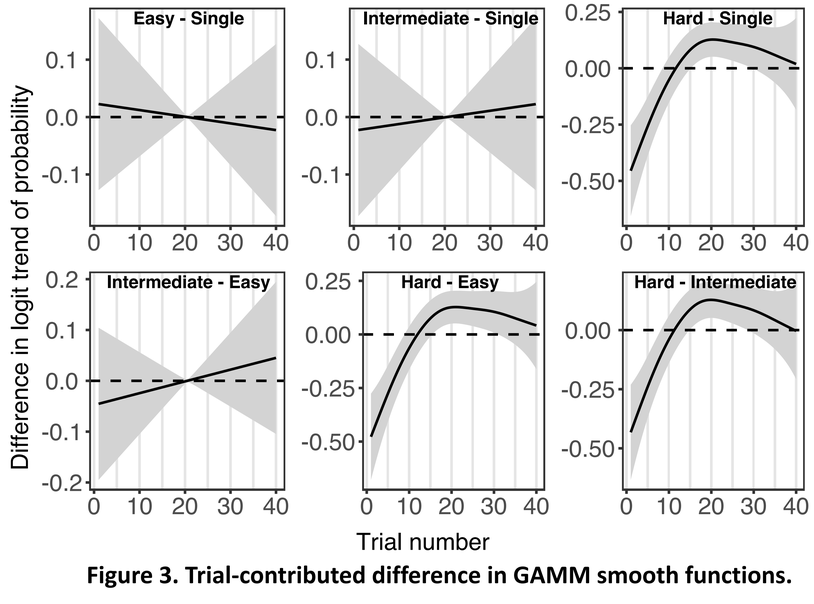

Figure 3. Trial-contributed difference in GAMM smooth functions.

- Visual task performance was modulated by task difficulty (Fig. 4).
- **Adaptation** to speech was **found in all task conditions** (Fig. 2).
- **Adaptation** was linear and intact under easy and intermediate visual conditions but was **more pronounced under the hard condition**.
- The hard condition had a significantly **steeper improvement** for the **first 8 trials**, but a remarkably **slower learning** between **trial 15-30** than other conditions (Fig. 3).

Discussion

- Speech perceptual learning was resilient to divided attention.
- Performance cost of divided attention in the hard condition was mitigated by robust adaptation during early exposure.
- Absence of adaptation in [2] might be explained by task-irrelevance (i.e., passive listening to speech).
- In summary, our results show that **full attention is not required for rapid adaptation** to degraded speech.

References: [1] Davis *et al.*, J. Exp. Psychol. Gen., 134 (2), 222-241, 2005. [2] Feldman & Friston , Front. Hum. Neurosci., 4 (December), 1-23, 2010. [3] Huyck & Johnsrude, J. Acoust. Soc. Am., 131(3), EL236–EL242, 2012.