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Statistical learning at a cocktail party

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Materials and data analysis:
https://osf.io/zc543/

Background

Statistical learning (SL): the ability to draw upon distributional regularities.

SL is key in language learning, helping to identify word boundaries through computation of transitional probabilities (TPs) between syllables[1,2].

Yet, most empirical evidence comes from studies examining learning without distractions. However, natural language acquisition takes place amidst a plethora of acoustic distractions, including competing speech in multi-talker (or "cocktail-party") settings.

Here, we assess how statistical learning proceeds in the presence of another competing speech stream with its own statistical regularities.

[RQ1] Do participants exposed to two competing talkers perform as accurately in SL as participants exposed to a single talker?
[RQ2] Does selective attention modulate SL? That is, within the Dual Talker group, do we find greater accuracy for the attended vs. unattended talker?

Method

- 96 adults (native Dutch-speaking, M_{age} = 25 years)
- Online experiment; Between-participants design with 2 exposure groups (each N = 48): *Dual Talker* and *Single Talker (control) group*

Training

- Two continuous speech streams, each comprising 6 unique trisyllabic words (within-word TP = 1; mean between-word TP = 0.2)
- *Dual Talker group:* concurrently exposed to two distinct streams, produced by different talkers (M vs. F) with full virtual spatial segregation (using binaural ITD and ILD manipulations). Participants were asked to attend to one stream (***Attended Language; AL***) and ignore the other (***Unattended Language; UL***); counter-balanced across listeners.
- *Single Talker group:* heard one stream from a single talker diotically
- Sex of speaker and lang. version counterbalanced across participants.
- Tone detection task to ensure attention throughout familiarisation.

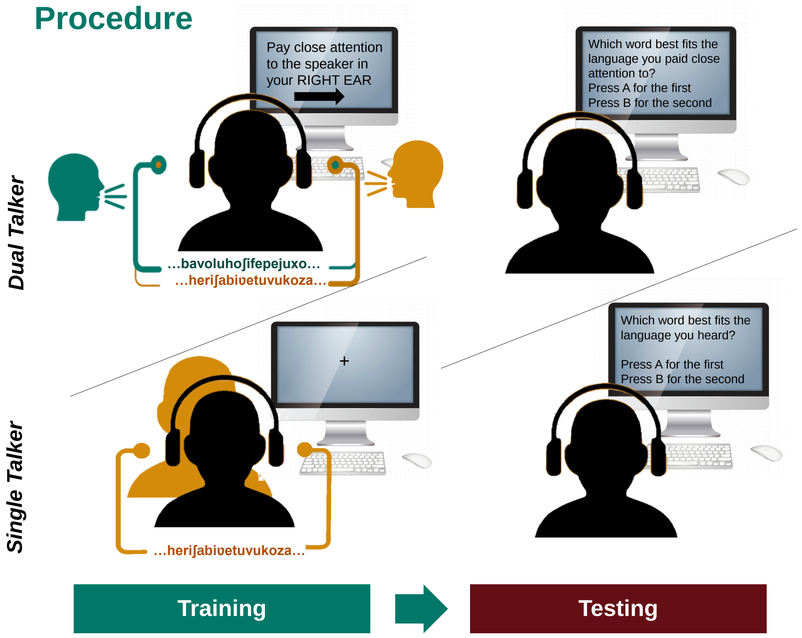
Test

- 2AFC tests of ***segmentation*** *for* ***AL*** *and* ***UL*** (word vs. part-word) and ***recognition*** (AL word vs. UL word)
- All participants completed the same test phase.

	AL exposure	UL exposure	Seg. Test for AL	Seg. Test for UL*	Rec. Test
Dual Talker	…heriʃa,biʊetu, vukoza…	…kireʊa,bavolu, hoʃife…	heriʃa vs. riʃa-bi	bavolu vs. ʊa-bavo	heriʃa vs. bavolu
Single Talker	…heriʃa,biʊetu, vukoza…	-	heriʃa vs. riʃa-bi	bavolu vs. ʊa-bavo	heriʃa vs. bavolu

*UL for the Single Talker group corresponds to the stream they were not exposed to

Procedure



Results

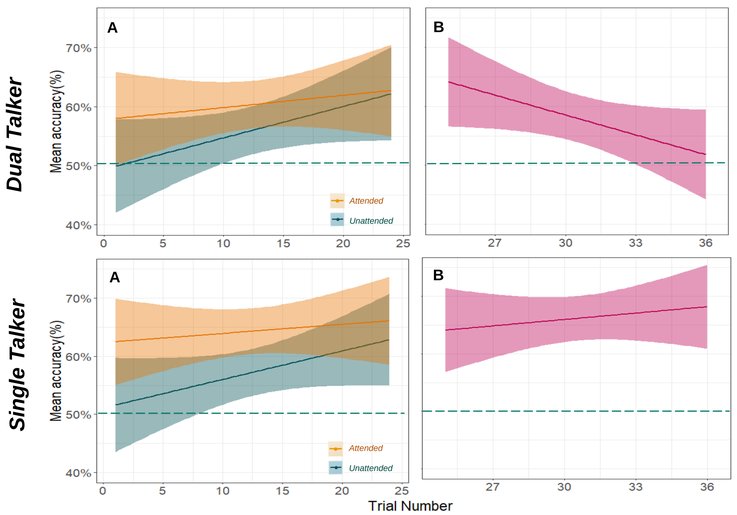


Figure 1. Accuracy scores for the segmentation and recognition tests in the Dual and Single Talker group over the course of the task (with lm smooth and 95% confidence band). **Panel A** shows performance on the segmentation trials for the **Attended Language** and the **Unattended Language**. **Panel B** shows **recognition** trials.

Results

Segmentation Test

- GLMER analysis (random effects: participants, test-pair).
  Models were built incrementally; fixed effects were retained if significant.
- Significant effect of attention (model fit improvement: $\chi(1)^2 = 6.255$, p = .012); significantly worse performance in the segmentation trials for the ***UL*** compared to the ***AL*** (β = -.268, *SE* = .104, z = -2.569, p = .010)
- No significant effect of Group (no improvement in model fit: $\chi(1)^2 = 1.675$, p = .196); Dual Talker group's overall performance was similar to that of the Single Talker group (β = -.114, *SE* = .088, z = -1.295, p = .196)
- Significant effect of trial number(model fit improvement: $\chi(1)^2 = 4.370$, p = .034), participants' performance improved over the course of the segmentation test (β = .101, *SE* =.048, z = 2.115, p = .036).

Recognition Test

- GLMER analysis (random effects: participants, test-pair); models built incrementally; fixed effects were retained if significant.
- Significant effect of Group (model fit improvement: $\chi(1)^2 = 6.390$, p = .011); Dual Talker group's performance significantly worse than that of the Single Talker group (β = -.356, *SE* =.139, z = -2.56, p = .011)
- Marginally significant Trial Number-Group interaction model fit improvement: $\chi(1)^2$ =3.114, p = .077); slight tendency for Dual Talker group to perform worse over the course of the rec. test (β = -.219, *SE* =.124, z = -1.764, p = .078)

Conclusion

We found that the Dual Talker group performed as accurately on segmenting the attended language [segmentation trials] as the Single Talker group did. This suggests that SL was not affected by the increase of cognitive load. Moreover, segmentation performance for the AL was higher than performance for UL. This shows that statistical learning is strongly modulated by selective attention: selective attention allows listeners to perform as if the competing talker wasn't there.

But did the Dual Talker group learn nothing at all from the UL? Well, they did perform worse than the Single Talker group when having to choose between words from AL vs. UL [recognition trials]. This suggests a small amount of learning of the UL.

1. Saffran, J. R., Newport, E. L., & Aslin, R. N. (1996). Word Segmentation: The Role of Distributional Cues. *Journal of Memory and Language*, *35*(4), 606–621.
2. Saffran, J. R., Newport, E. L., Aslin, R. N., Tunick, R. A., & Barrueco, S. (1997). Incidental Language Learning: Listening (and Learning) Out of the Corner of Your Ear. *Psychological Science*, *8*(2), 101–105.