The Leslie and Susan Gonda Multidisciplinary Brain Research Center
Bar-Ilan University

The Human Brain Dynamics Lab

An ecological investigation of effect of noise on neural tracking and speech perception in a Virtual Classroom

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Background

- Speech comprehension is a fundamental ability in learning and encoding new information. However, in real-life situations, natural speech is often accompanied by irrelevant background noises which need to be ignored.
- While most research to date used artificial stimuli and designs, **the goal of our study** is to mediate between lab conditions and real-life experience.
- **We study the effects of two different types of noise, Continuous vs. Intermitted, on speech perception in an environment that simulates real-life condition: A Virtual Reality Classroom.**

Hypothesis

Both intermitted and continuous noise have **detrimental effects** on speech processing.

VS

Intermitted noise has "noiseless gaps" that give the listeners the opportunity to fill in the portions of speech that were masked by the noise.

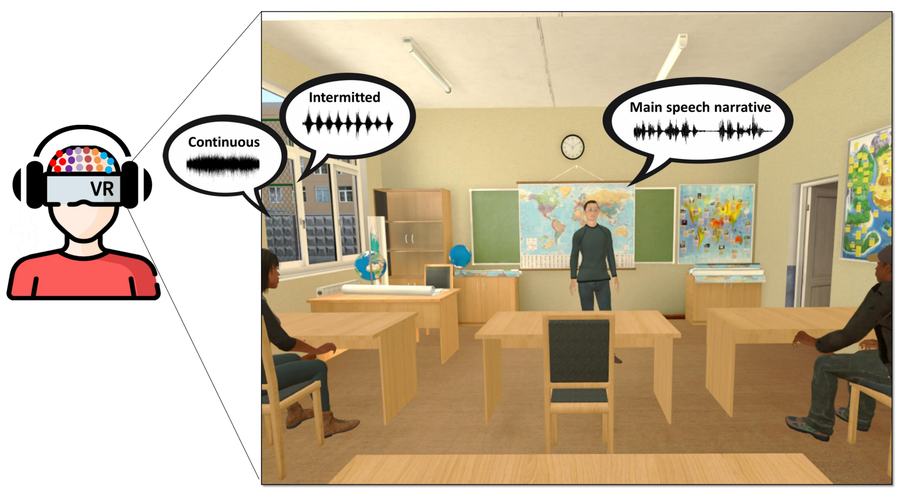
VS

The monotonic nature of **continuous** noise makes it less disruptive to speech processing, since the system habituates to it over time.

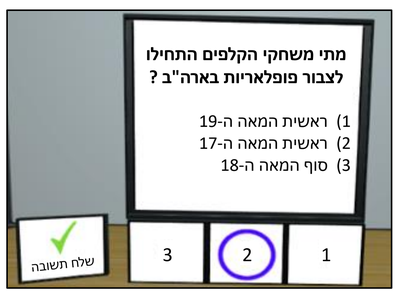
Experimental design

30 trials, each trial contains:
Task relevant stimuli: Hebrew Podcasts (~40 sec)
1 of 3 types of conditions (randomly spread):
Silence | Intermitted drilling | Continuous construction

Participants
- N = 32 (19 females, 13 males)
- Mean age: 24.625 ± 3.858
- Normal hearing, Native Hebrew speakers



4 questions after each trial about the narrative content :

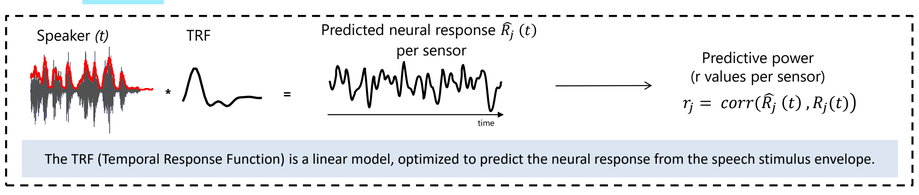


Mesurements

Type of Measurement:	Measure how the presence of noise affects the:
EEG **64 electrodes** Neural Response	- Neural processing of speech
GSR **2 electrodes** Skin-conductance	- State of arousal - Cognitive effort
Eye-movement Eye-gaze patterns	- Covert attention - Gaze-shift frequency
Multiple choice questions Behavioral performance	- Learning and Memory

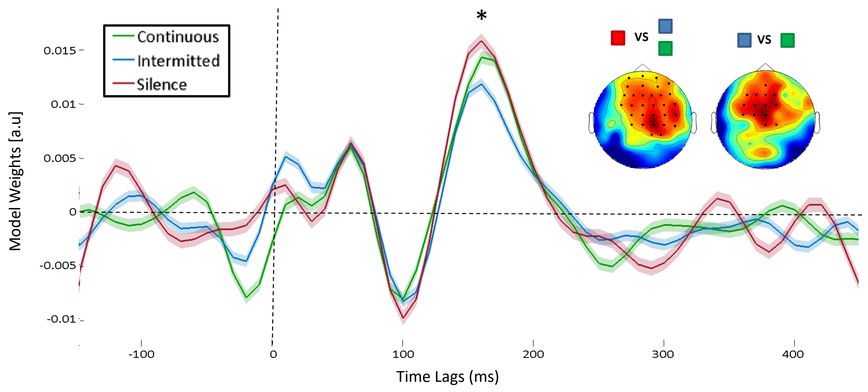
EEG Results - TRF

(n=30)

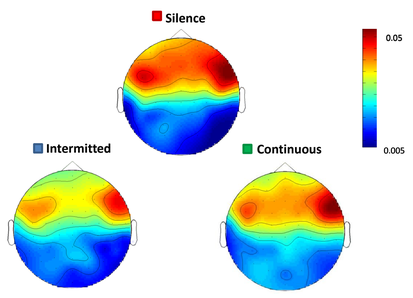


The TRF (Temporal Response Function) is a linear model, optimized to predict the neural response from the speech stimulus envelope.

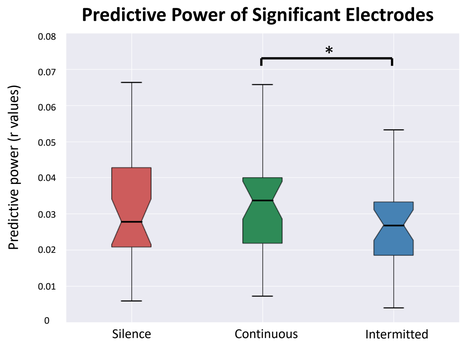
Speech Tracking Response



Encoding predictive power



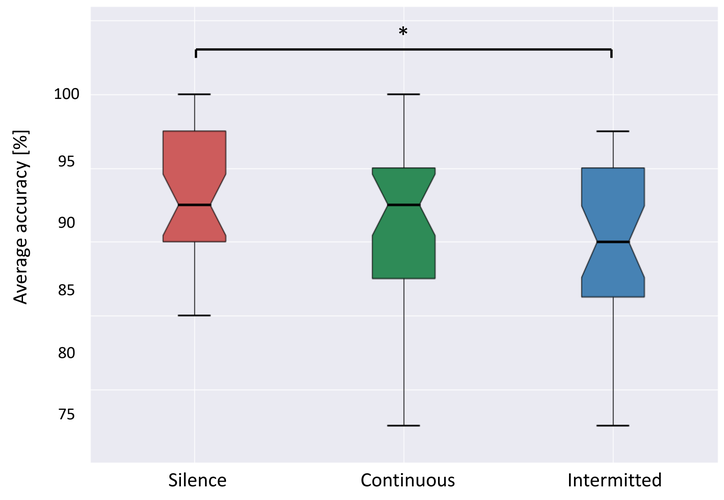
Predictive Power of Significant Electrodes



*The speech tracking response **decreases** in the presence of noise, particularly when the noise is **intermitted**.*

Behavioral Results

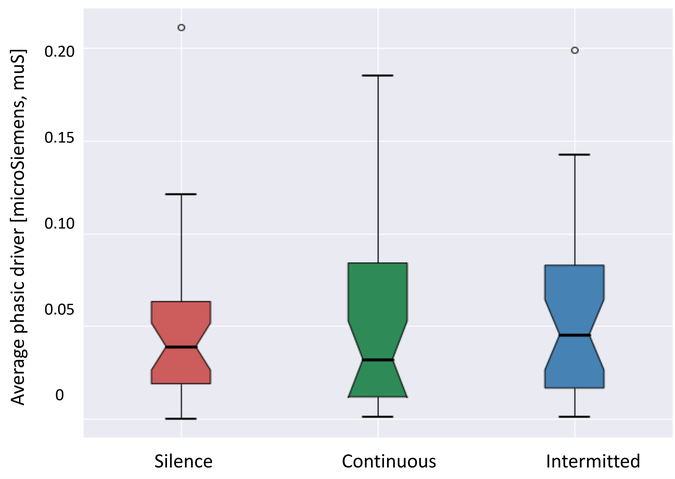
(n=32)



*Participants are **more accurate** under **silence** condition **than** under **intermitted** condition.*

GSR Results

(n=30)



*There are **no significant GSR differences** between conditions.*

Eye-tracking Results

(n=32)

% Gaze time \ trial over all conditions

*Comparison of the eye-gaze patterns **does not reveal systematic differences between conditions**. Suggesting that the participants were able to focus their gaze on the teacher despite the noise.*

EEG Results - Alpha

(n=30

*Alpha power does **not differ significantly** between conditions, but there is **a large variance between subjects.***

Conclusion

- By using this multimodal ecological setup, we were able to observe how the brain responds to stimulus overload in a realistic and true-to-life environment.
- We found significant speech tracking and behavior differences between conditions.
- Arousal-related physiological measurements (GSR, eye movements, alpha) did not differ across noise conditions, but were correlated with each other.

Correlations – To be continued…

Our research is still in the early stages of exploring the relationship between the measurements, but the correlations do indicate relationships.