

Sequential predictions enhance auditory sensitivity

- MARIN N.¹, GÉRENTON G.¹, JEAN H.², PARAOUTY N.², WALLAERT N.², LAZARD D.³, DOELLING K.B.^{1*}, ARNAL L.H.^{1*} -

¹ Université Paris Cité, Institut Pasteur, AP-HP, Inserm, Fondation Pour l'Audition, Institut de l'Audition, IHU reConnect, F-75012 Paris, France.

² iAudiogram, Reims, France. ³ Princess Grace Hospital, ENT & Maxillo-facial Surgery Department, Monaco * co-authorship



ABSTRACT

Human hearing is highly sensitive and allows us to detect acoustic events at low levels.

However, sensitivity is not only a function of the integrity of cochlear transduction mechanisms, but also constrained by central processes such as attention and expectation.

While the effects of distraction and attentional orienting are generally acknowledged, the extent to which probabilistic expectations influence sensitivity at threshold is not clear.

Classical audiometric tests, commonly used to assess hearing thresholds, do not distinguish between bottom-up sensitivity and top-down processes. In this study, we aim to decipher the influence of various types of expectations on hearing thresholds and how this information can be used to improve the assessment of hearing sensitivity.

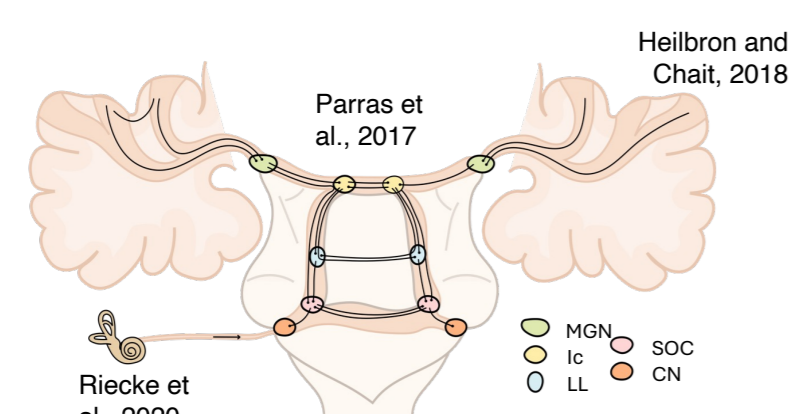
Our results raise important questions regarding the conventional assessment of hearing thresholds, both in fundamental research and in audiological clinical assessment.

INTRODUCTION

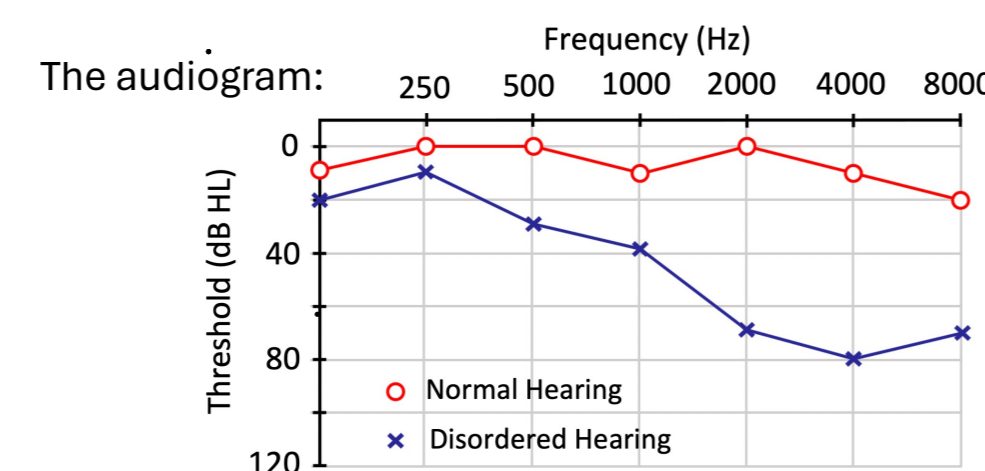
Prediction plays diverse roles in hearing

- Aided signal in noise detection (ten Oever et al., 2014)
- Audiovisual speech integration (Peelle and Sommers, 2015)
- "Groove", aka the urge to dance (Stupacher et al., 2022)
- ...

Evidence of hierarchical predictive processes exists at several stages in the auditory system



When measuring hearing abilities, the sounds presented are often predictable



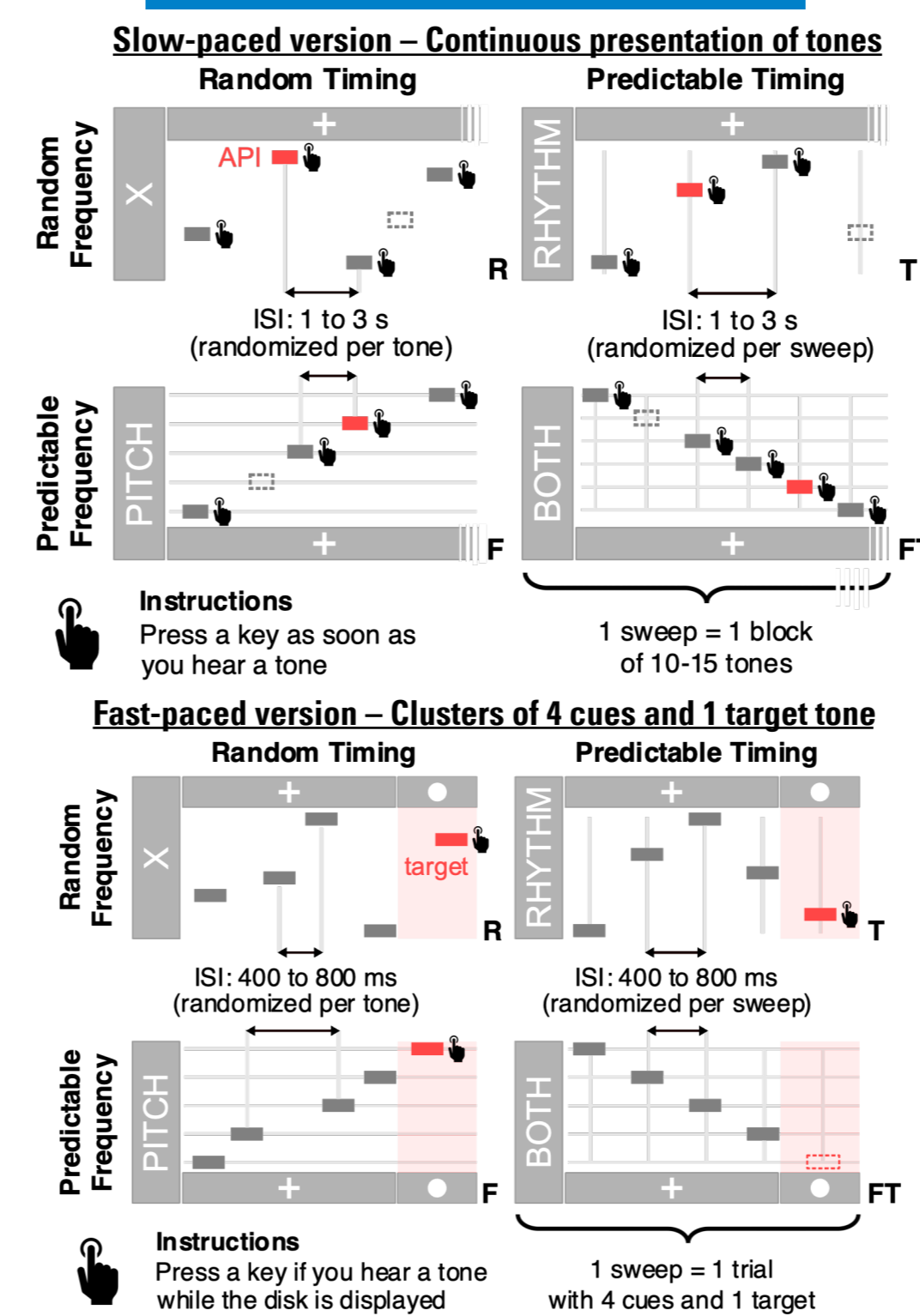
Adaptive procedures are the standard



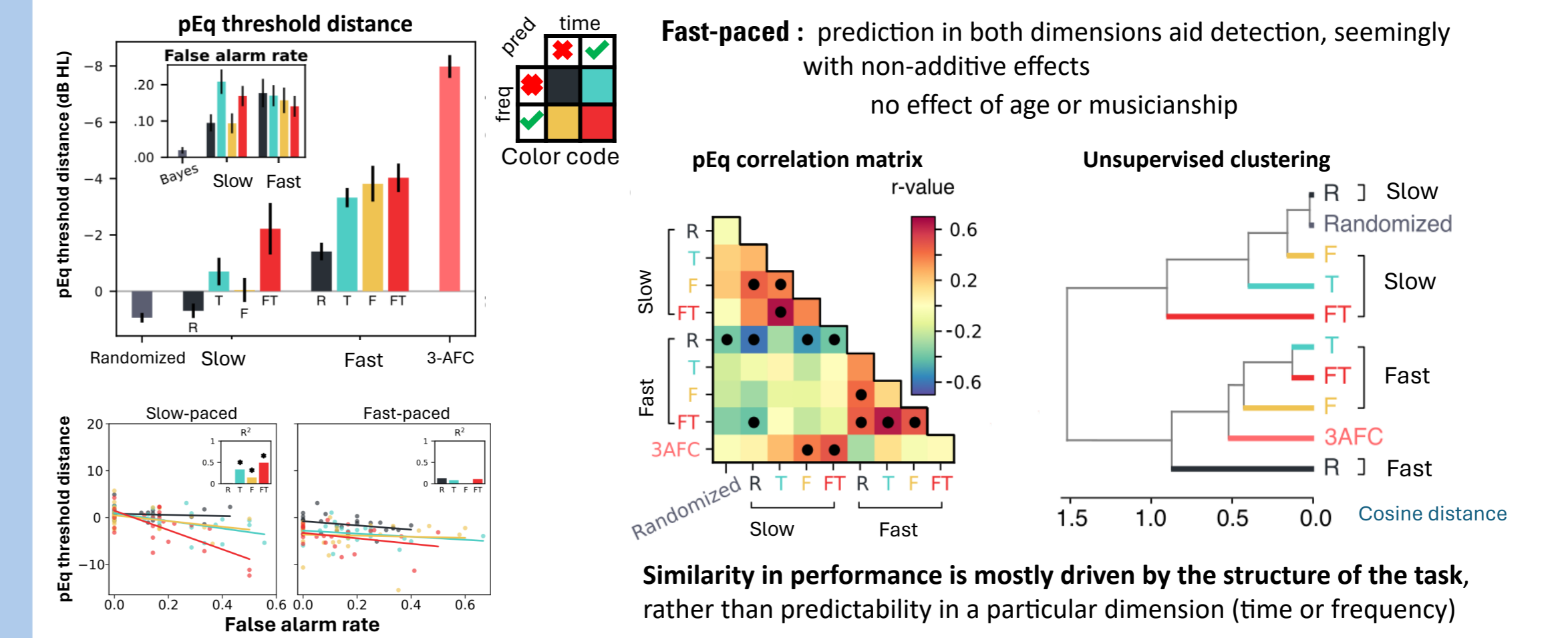
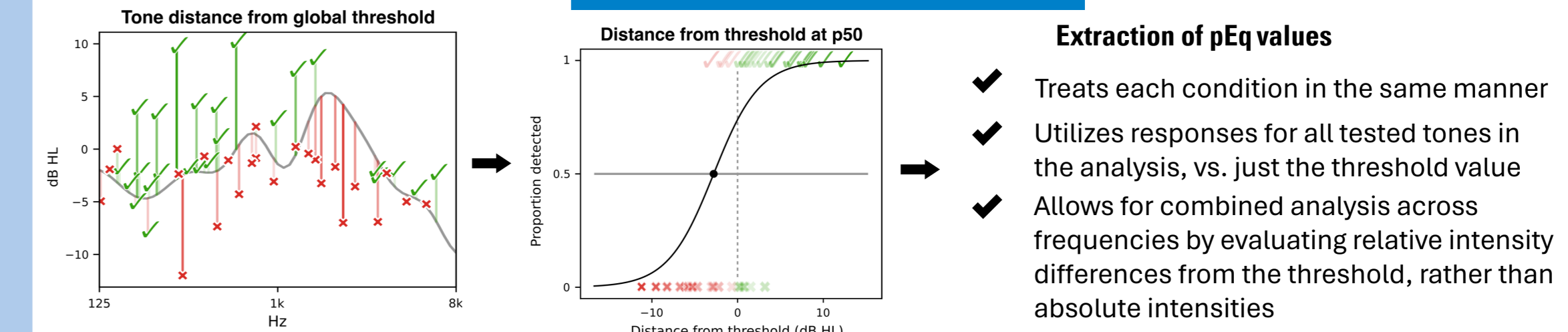
BUT they carry a lot of predictive information:

- the timing of tones is more or less regular
- the tested frequencies are repeated and change following a pattern

EXPERIMENT 2



ANALYSIS



CONCLUSION

Pure tone detection thresholds can be substantially affected by predictive structure in audiological exams.

-7.5 dB on average between our most extreme conditions in normal hearing participants, maybe higher for hearing loss patients because of potential long-term plastic compensatory effects.

In a more controlled task design, using timescales similar to those of clinical paradigms, prediction in time seems to induce a more liberal response bias: this highlights the importance presenting tones non-rhythmically.

Task structure primarily drives performance similarities, suggesting that different timescales and/or differences in temporal attention may recruit distinct mechanisms for utilizing predictive information.

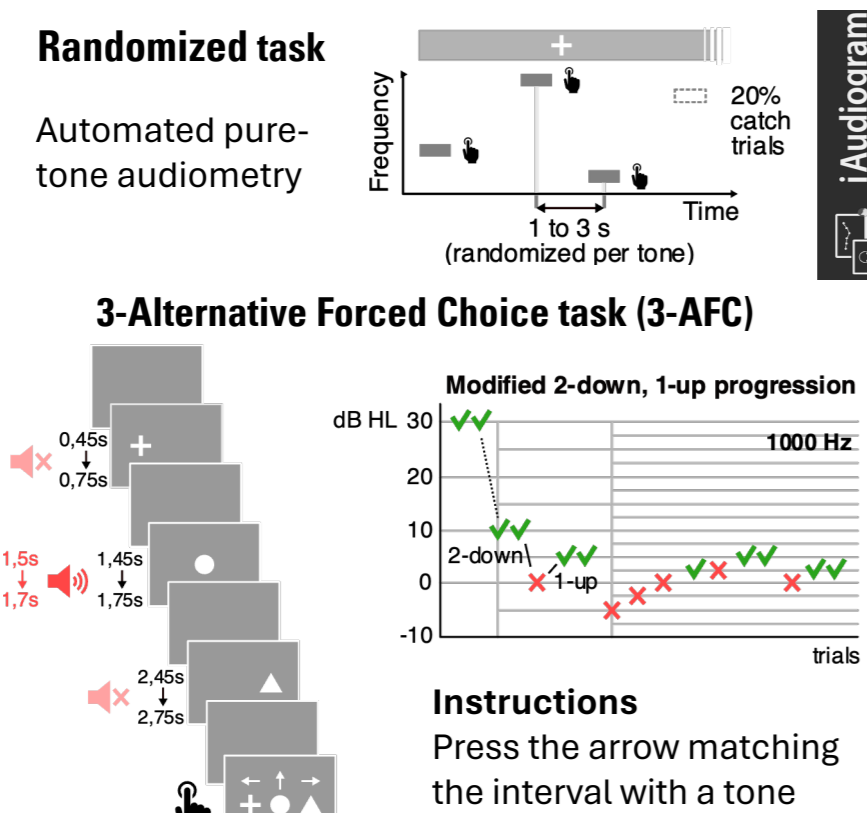
REFERENCES

- ten Oever, S., Schroeder, C. E., Poeppel, D., van Atteveldt, N. & Zion-Golumbic, E. Rhythmicity and cross-modal temporal cues facilitate detection. *Neuropsychologia* 63, 43–50 (2014).
- Peelle, J. E. & Sommers, M. S. Prediction and constraint in audiovisual speech perception. *Cortex* 68, 169–181 (2015).
- Stupacher, J., Matthews, T. E., Pando-Naude, V., Foster Vander Elst, O. & Vuust, P. The sweet spot between predictability and surprise: musical groove in brain, body, and social interactions. *Front Psychol* 13, 906190 (2022).
- Heilbron, M. & Chait, M. Great Expectations: Is there Evidence for Predictive Coding in Auditory Cortex? *Neuroscience* 389, 54–73 (2018).
- Parras, G. G. et al. Neurons along the auditory pathway exhibit a hierarchical organization of prediction error. *Nat Commun* 8, 2148 (2017).
- Riecke, L., Marianu, I.-A. & De Martino, F. Effect of Auditory Predictability on the Human Peripheral Auditory System. *Front Neurosci* 14, 362 (2020).

METHODS

- 28 participants (12 M - 16 F) 18 to 41 year-old normal hearing (< 20 dB HL loss)
- 1h30 sessions compensated 10€/h
- Tones presented binaurally through insert earphones Inside a sound-attenuated booth
- 200 ms pure tones Range: 125 – 8000 Hz
- Musical Sophistication (Gold-MSI)

EXPERIMENT 1



RESULTS

