

Do brain-body rhythms shape individual timing capacities?

The ability to successfully navigate in a dynamically changing environment relies on adaptive mechanisms that allow humans to encode and predict the timing of external events. However, humans vary in their capacity to adapt to change. It is therefore important to explain how individual's sub-second temporal sensitivity factors into behavior and aligns with specific rate and variability in peripheral (breathing, heart rate) and neural brain rhythms. Rapid, precise, and adaptive timing in this range is fundamental to neural and cognitive processes. However, the very relationship between an individual's timing capacity and its oscillatory peripheral and neural signature(s) is yet to be determined. Consequently, the current project will use a multimethod approach utilizing physiological, behavioral, and neuroimaging methods to synthesize these aspects into an individual timing fingerprint.

The current research project will adopt a basic and potentially translational approach, and will specifically examine the nature and contribution of cortico-subcortical structures in individual timing (Criscuolo et al., 2022a; 2022b; Kotz et al., 2016; 2018; Schwartz & Kotz, 2013).

Analyses will focus on neural oscillations, and will assess the neural predispositions to sample the acoustic environment and process temporal regularities. In particular, we expect delta-band (1-3Hz) neural activity to internalize the timing of external events, and anticipate tone onsets (Criscuolo et al., 2022a). Furthermore, we expect to observe a complementary role of low-beta oscillations (Biau and Kotz, 2018) in the encoding of temporal regularities. Heart rate and breathing rates will be investigated as potential modulators of brain rhythms.

References:

Biau, E., Kotz, S.A. (2018). Lower beta: A central coordinator of temporal prediction in multimodal speech. *Front. Hum. Neurosci.* 12, 1–12. <https://doi.org/10.3389/fnhum.2018.00434>

Criscuolo, A., Schwartz, M., Henry, M.J., Obermeier, C., Kotz, S.A. (2022a). Individual neurophysiological signatures of spontaneous rhythm processing. *bioRxiv* 2022.03.14.484286. <https://doi.org/10.1101/2022.03.14.484286>

Criscuolo, A., Schwartz, M., & Kotz, S.A. (2022b). Cognition through the lens of a body-brain dynamic system. *Trends Neurosci.* 45(9):667-677. doi: 10.1016/j.tins.2022.06.004.

Kotz, S.A., Brown, R.M., Schwartz, M., 2016. Cortico-striatal circuits and the timing of action and perception. *Curr. Opin. Behav. Sci.* 8:42-45. <https://doi.org/10.1016/j.cobeha.2016.01.010>

Kotz, S.A., Ravnani, A., Fitch, W.T., 2018. The Evolution of Rhythm Processing. *Trends Cogn. Sci.* 22, 896–910. <https://doi.org/10.1016/j.tics.2018.08.002>

Schwartz M, Kotz SA. (2013). A dual-pathway neural architecture for specific temporal prediction. *Neurosci Biobehav Rev.* 37:2587-96. doi: 10.1016/j.neubiorev.2013.08.005.

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Techniques to be used: electroencephalography (EEG), peripheral measures (breathing, heart rate), and time-series analysis.

Link with the master thesis of the proposed student:

Key words: Basic Research, Clinical, Pre-clinical, Health.