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Simone Battaglia[a], Stefano Orsolini[b], Sara Borgomaneri[a] , Riccardo Barbieri[c], Stefano Diciotti[b], Giuseppe Di Pellegrino[a]

[a] University of Bologna, Department of Psychology, Bologna, Italy,

[b] University of Bologna, Department of Electrical, Electronic and Information Engineering, Bologna, Italy,

[c] Politecnico di Milano, Department of Electronics, Information and Bioengineering, Milano, Italy

Background and aims: Understanding transient dynamics of autonomic control during emotional learning is crucial to translate basic research into the treatment of psychopathology. Fear learning typically elicits short-latency bradycardia in humans. Yet, standard analyses of heart rate variability (HRV) fail to disentangle the contribution of parasympathetic and sympathetic activation, and to capture phasic changes of HRV during fear learning.

Methods: To this aim, 50 healthy participants (mean age = 24 years) underwent a fear conditioning and extinction protocol. Two novel approaches were used to perform a frequency-domain analysis of HRV: short-time Fourier transform and instantaneous spectral estimation. Specifically, we tested whether the spectral components of the HRV, used as a non-invasive biomarker of sympathetic and parasympathetic activity, are able to distinguish between fear conditioned and neutral stimuli.

Results: We found that learned fear elicited a profound heart rate deceleration in anticipation of noxious stimuli. More importantly, results revealed significant increases in spectral power in the high-frequency (0.15–0.40 Hz) band, indicating a specific vagal contribution, which robustly and reliably distinguished conditioned from neutral stimuli during fear learning.

Conclusions: These results provide unique evidence of the direct involvement of the parasympathetic (vagal) component of the autonomic nervous system during fear learning. These laboratory findings can be readily translated into the clinical field, thereby providing a novel and accessible tool to evaluate several psychopathological processes, and quantify deficits of Vagus nerve modulation of HRV during emotional responding in humans.