Joie: An Affective Brain-computer Interface (BCI) for Learning Mental Strategies for Positive Affect

Angela Vujic[1], Shreyas Nisal[1], Ashley Martin[1], Pattie Maes[1]

[1]*MIT Media Lab, Cambridge, MA, USA*

*75 Amherst St., Cambridge, MA 02141. Email: avujic@mit.edu

Introduction: Neurofeedback training to increase left frontal brain activity may help reduce symptoms of anxiety and depression [1]. We designed Joie, a novel affective brain-computer interface (BCI) which seeks to help users learn mental strategies for positive affect that can be used to regulate frontal alpha asymmetries. We evaluated the impact of teaching users mental strategies on BCI performance, defined as the increase in left-frontal activity after 5 training sessions.

Material, methods and results: We recruited participants (N=20, M= 11, F= 8, NB=1, Age_{mean} = 27.65, Age_{range}= [21,44]) who reported having no known gastrointestinal, neurological, or psychiatric disorders except for anxiety conditions, to play 5 Joie sessions over two weeks (40 minute gameplay, 3x 8-minute training per session). Participants in our experimental group were taught about approach and withdrawal motivation [2] and instructed to "imagine people or animals they love", "positive upbeat music", "future or past happy memories", or create their own similar strategy. We found that number of training sessions significantly predicted increased baseline-adjusted left-activation for our experimental group ($G_{treatment}$: $F_{2,102}$ = 3.31, $P <$ .05*, R^2 = 0.06) while for the placebo and control groups no significant change was observed ($G_{placebo}$: $F_{2,90}$ = 0.881, $P > $.05, R^2 = -0.002, $G_{control}$: $F_{2,83}$ = 1.86, $P > $.05, R^2 = 0.02).
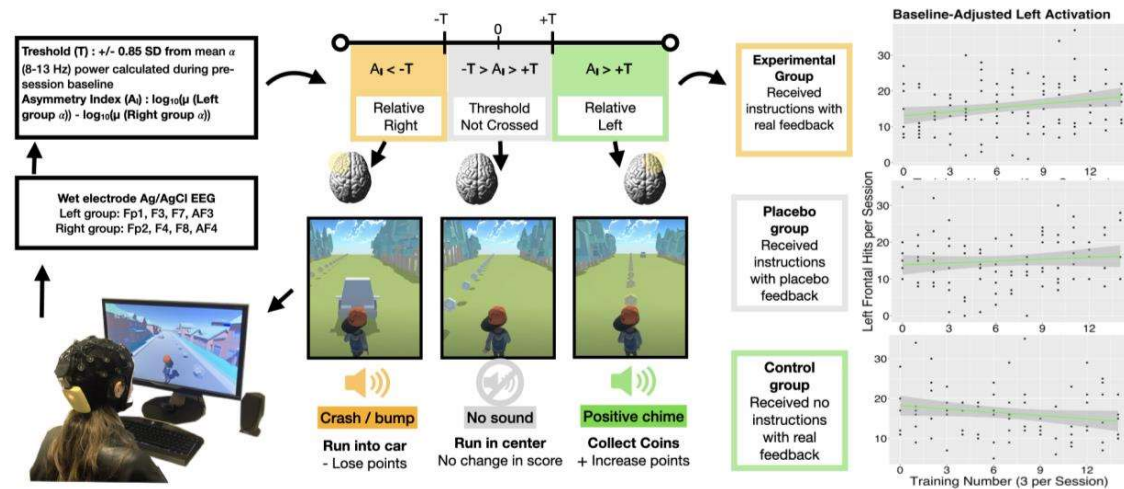

Figure 1. The Joie gameplay setup, operant conditioning paradigm and experimental results. When participants would cross the "relative left" threshold, their character would collect coins. Only the experimental group saw a group-level positive increase.

Discussion and Significance: The participants in the experimental group learned to regulate their frontal alpha over training sessions. The results support the use of the approach and withdrawal model of emotion to create BCIs, also seen in [3]. They also support the possibility that with minimal instruction and guidance, users can learn to create cognitive strategies to modulate frontal asymmetries. Future research directions can expand on this result to demonstrate how this can be used to reduce anxious or depressive symptoms.

References:

[1] Trambaiolli, Lucas R., et al. "Neurofeedback training in major depressive disorder: a systematic review of clinical efficacy, study quality and reporting practices." Neuroscience & Biobehavioral Reviews 125 (2021): 33-56.

[2] Quaedflieg, Conny WEM, et al. "The validity of individual frontal alpha asymmetry EEG neurofeedback." Social cognitive and affective neuroscience 11.1 (2016): 33-43.

[3] Aranyi, Gabor, Fred Charles, and Marc Cavazza. "Anger-based BCI using fNIRS neurofeedback." Proceedings of the 28th Annual ACM Symposium on User Interface Software & Technology. 2015.