Neurophysiologic Findings on Trace Conditioning

SFB 636

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Trace conditioning

In trace conditioning, there is a gap between the offset of a CS and onset of an US, requiring the subject to keep a memory "trace" in mind in order to learn the association between CS and US (1). Although most paradigms are rather simple, not all subjects become aware of the connection between the stimuli. So it is necessary to control whether the association has been learned. In aversive trace-conditioning different neurophysiologic parameters (skin conductance response, heart rate) can be used to control subjects' anticipation of a following US.

Skin conductance response (SCR)

Emotional activation during the presentation of an aversive stimulus is associated with an increase in skin conductance. In aversive learning paradigms, the SCR is used as a neurophysiologic parameter differentiating between CS+ and CS- (1). We would expect that the SCR shows a higher First Interval Response (FIR) after the presentation of CS+ than after CS-.

Furthermore, we expect a Second Interval Response (SIR) after exposition to CS+ as an anticipatory reaction to the following US.

Event related potentials (ERP)

Event related potentials occurring between CS onset and US are thought to represent the activity of the central nervous system involved in processing the acquired information of the visual stimuli presentation. As far as we know, ERPs have not yet been used together with trace-conditioning. We expect a surface activity especially in frontocentral, centrotemporal and centroparietal areas representing the activity of the medial temporal lobe. Recent ERP studies exploring memory functions with different paradigms focus on the P300 component and on later occurring components (LPC) as electrophysiological correlates of memory processes involving the medial-temporal lobe system (2;3).

Paradigm

As in classical conditioning we conducted a habituation, an acquisition and an extinction phase. Distinct symbols were used as conditioned stimuli. An unpleasant, but not painful electric shock to the middle finger of the dominant hand served as US. In the acquisition phase 48 CS+ (50% unpaired) and 48 CS- were presented. ERPs were obtained from a 64-channel EEG. In our pilot study we included 6 healthy volunteers. Additionally, we assessed skin conductance response.

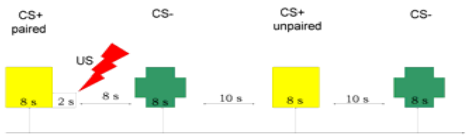

Fig. 1: Acquisition phase: US follows CS+ in 50%

Preliminary findings

In a preliminary study we analyzed SCR of 4 subjects and ERPs of 6 subjects.

SCR in Acquisition Phase:

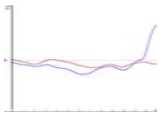

Fig.2: Trials 1-16 : SCR after CS+ (blue) and CS- (red)

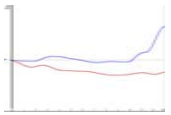

Fig. 3: Trials 17-32 : SCR after CS+ (blue) and CS- (red)

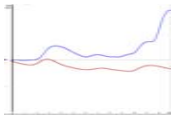

Fig. 4: Trials 33-48 : SCR after CS+ (blue) and CS- (red)

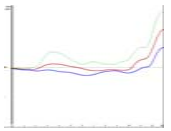

Fig. 5: SCR after CS+ on trials 1-16 (blue), 17-32 (red) and 33-48 (green)

ERPs in Acquisition Phase:

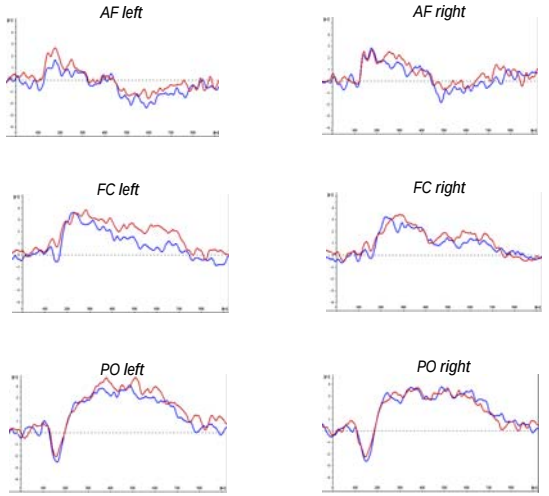

Fig. 6-11: ERPs (anteriorfrontal (AF), frontocentral (FC) and parietooccipital (PO) areas) of the left and right hemisphere for CS+ (blue) and CS- (red)

- SCR after CS+ showed a higher FIR amplitude compared to after CS- which increases over the time (Fig 2-4)
- 10 sec after CS+ there is a possible SIR (Fig. 5)
- ERPs (Fig. 6-11) showed amplitude differences in an early time window in frontal areas and in a later time window in centrotemporal areas (both left-hemispheric accentuated)

References

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•2: Rugg, M.D., Walla, P., Schloerscheidt, A.M., Fletcher, P.C., Frith, C.D., Dolan, R.J. (1998). Neural Correlates of Depth of Processing Effects on Recollection: Evidence from Brain Potentials and Positron Emission Tomography. Exp. Brain Res., 123; 18 – 23.
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