

A P300 Brain-Computer Interface as a Diagnostic Tool for Measuring the Efficacy of Psychotherapeutic Intervention

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Introduction: Systemic therapy is a psychotherapeutic treatment that focuses on the patient's social and family relationships. It uses the Family Constellation Method (FCM), in which patients externalize a representation of their experienced family constellation by arranging people representing family members in a room. Non-verbal aspects, including distance between people, direction of gaze, and facial expression, are interpreted to facilitate the patient's insight into their family constellation. This process can lead to new insights or the revival of emotions from past experiences and is expected to have a positive impact on the patient's social interactions and well-being in the present. For example, if a person discovers through FCM that there was an unspoken rule in his or her family of origin to avoid conflict and maintain harmony, that person may be able to reconsider the pattern of avoiding conflict in current relationships. The efficacy of the FCM has been demonstrated [1], however, mainly questionnaires and subjective reports were used to evaluate therapeutic success. We argue that the efficacy of the FCM should have a neural correlate that might be measurable using a P300-based brain computer interface (BCI). According to Johnson's Triarchic Model, the P300 amplitude is influenced by the meaning of a stimulus [2]. We hypothesized that the P300 amplitude would increase for spelling words representing improved social interactions after undergoing the FCM as due to an increased meaning to the participant. We predicted that this P300 increase would exceed the P300 increase observed for control words.

Material, Methods and Results: For this pilot study we recruited 3 female participants, 31 (A), 34 (B), and 39 (C) years old from the Würzburg Systemic Institute and all of them participated in a family constellation seminar as part of their training to become counsellors. We assessed their subjective experience in social systems using the EXIS.pers questionnaire [3] which comprises 12 items assessing the subscales Belonging, Autonomy, Accord, and Confidence before and after undergoing the FCM. Higher values in the subscales represent more satisfying social experiences. For the BCI spelling task, we chose 12 words, two representing one category (e.g. autonomous and self-determined for Autonomy) and four control words. Participants spelled these words before and after participation in the FCM. We measured Fz, FCz, C3, Cz, C4, CPz, P3, Pz, P4, PO7, Oz and PO8, used two electrodes at the outer canthi for horizontal EOG and two electrodes for the vertical EOG. We used a 16-channel g.Tec amplifier (g.Tec, Austria) with a sampling rate of 256 Hz, a high pass filter of 0.1 Hz, a low pass filter of 30 Hz, and a notch filter of 48–52 Hz. The spelling was controlled by the BCI 2000 Software [4]. In all three participants the questionnaire scores increased in some subscales, but the P300 amplitudes of the corresponding target words showed a decrease. In Participant B, the two subscales Accord and Autonomy did not change, but an increase in P300 amplitudes was found for the target words. For participant C, a decrease in the Confidence subscale resulted in increased P300 amplitudes for the corresponding target words. P300 amplitudes decreased for control words for participants A and B, but remained constant for participant C.

Conclusion: Contrary to our hypothesis, P300 amplitudes decreased with improved subjective experience of social systems. This result may indicate that higher satisfaction with a component of social interaction, such as autonomy, leads to subjectively lower meaning of corresponding target words, compared to our hypothesis of higher meaning. Before we can interpret these results further, they need to be confirmed in a larger sample.

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References:

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