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Changing facial affect recognition in schizophrenia: Effects of training on brain dynamics

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ABSTRACT

Deficits in social cognition including facial affect recognition and their detrimental effects on functional outcome are well established in schizophrenia. Structured training can have substantial effects on social cognitive measures including facial affect recognition. Elucidating training effects on cortical mechanisms involved in facial affect recognition may identify causes of dysfunctional facial affect recognition in schizophrenia and foster remediation strategies. In the present study, 57 schizophrenia patients were randomly assigned to (a) computer-based facial affect training that focused on affect discrimination and working memory in 20 daily 1-hour sessions, (b) similarly intense, targeted cognitive training on auditory-verbal discrimination and working memory, or (c) treatment as usual. Neuromagnetic activity was measured before and after training during a dynamic facial affect recognition task (5 s videos showing human faces gradually changing from neutral to fear or to happy expressions). Effects on 10–13 Hz (alpha) power during the transition from neutral to emotional expressions were assessed via MEG based on previous findings that alpha power increase is related to facial affect recognition and is smaller in schizophrenia than in healthy subjects. Targeted affect training improved overt performance on the training tasks. Moreover, alpha power increase during the dynamic facial affect recognition task was larger after affect training than after treatment-as-usual, though similar to that after targeted perceptual–cognitive training, indicating somewhat nonspecific benefits. Alpha power modulation was unrelated to general neuropsychological test performance, which improved in all groups. Results suggest that specific neural processes supporting facial affect recognition, evident in oscillatory phenomena, are modifiable. This should be considered when developing remediation strategies targeting social cognition in schizophrenia.

1. Introduction

Deficits in social cognitive skills in schizophrenia patients (SZ) have been demonstrated in numerous studies. Facial affect recognition (FAR) is particularly relevant for effective social interaction (Johnston et al., 2010; Sachs et al., 2012; Wölwer et al., 2012). As impaired social cognitive skills are linked to functional impairment (e.g., Poole et al., 2000; Sachs et al., 2004; Hofer et al., 2009), remediation programs have targeted social-cognitive skills including FAR (e.g., Wölwer et al., 2005; Habel et al., 2010; Mazza et al., 2010; Wölwer and Frommann, 2011; Kurtz and Richardson, 2012). In their meta-analysis of 19 studies including 692 SZ, Kurtz and Richardson affirmed moderate-to-large effects on social cognitive measures (including facial affect identification tasks) and on observer-rated social function, with training effects varying with age, duration of illness, and extent of training.

Understanding brain processes contributing to social cognition deficits should facilitate the development and evaluation of tailored remediation strategies. Numerous studies have studied cortical and subcortical correlates of emotion processing in SZ including FAR (for hemodynamic imaging evidence, see Pinkham et al., 2007; Seiferth et al., 2009; Habel et al., 2010; Li et al., 2010; for event-related brain potential evidence, Turetsky et al., 2007; Wölwer et al., 2012; Wynn et al., 2013; for oscillatory activity, Singh et al., 2011; Popov et al., 2013, 2014).

These studies provide substantial evidence of deviant brain activity related to social cognition, including FAR. Yet few studies have evaluated the effects of social-cognition training on brain activity (Habel et al., 2010; Wölwer et al., 2012; Luckhaus et al., 2013). Popov et al. (2013) proposed a neural mechanism for such disrupted facial affect processing and its remediation. The study demonstrated group differences in 10–15 Hz (alpha) neuromagnetic oscillatory power modulation in bilateral sensorimotor regions while SZ and healthy controls (HC) viewed 5 s

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videos of dynamic facial stimuli that changed from neutral to fear or to happy expressions. During the period prior to correct affect recognition, HC exhibited a significant alpha power increase relative to baseline, whereas the significantly smaller increase in SZ varied with poorer discrimination accuracy. Because sensorimotor alpha activity has been linked to social information processing including FAR (e.g., Singh et al., 2011), the present study employed a targeted intervention to test the hypothesis that this recruitment of neural processes facilitates the recognition of unfolding facial affect in HC and is apparently impaired in SZ. Support for the hypothesis would mean that appropriate training can address deficits in recognition skills.

The present study evaluated a new Facial Affect recognition Training (FAT) protocol, designed specifically to address mechanisms facilitating FAR, and assessed alpha-power modulation as a possible mechanism of the training effect. Because beneficial effects of specific cognitive and/or social cognitive training protocols as add-ons to general SZ remediation programs have been reported (e.g., Keefe and Harvey, 2012; Sacks et al., 2013), the present study compared FAT with a well established cognitive training protocol, Cognitive Exercises (CEs; PositScience, SF, USA) already shown to be effective in SZ (Fisher et al., 2014; see also Popov et al., 2011, 2012). CE focuses on perceptual and cognitive skills and does not include facial or emotional judgments. Thus, it served as an active control for FAT's use of a training regimen. In between-group analyses, FAT and CE were compared with the inpatient unit's treatment as usual (TAU), which provided a nonspecific control for the passage of time and general treatment efforts. Analyses addressed a series of questions: Does training affect brain dynamics, and does specific training (FAT) affect specific FAR-related oscillatory dynamics? Does training normalize brain dynamics (does FAT reduce pre-training differences in FAR-related alpha dynamics between SZ and HC to nonsignificance)? To what extent are changes dependent on an active intervention in general (does FAT do so better than TAU) or on specific FAR-focused training (does FAT do better than CE)?

2. Methods and materials

2.1. Participants

Inpatients with an ICD diagnosis of paranoid-hallucinatory schizophrenia (code number 20.0) were recruited at the regional Center for Psychiatry. Inclusion criteria were normal intellectual function and no history of any neurological condition or disorder such as epilepsy or head trauma with loss of consciousness. According to the standard treatment regimen of the Center, all patients were stably medicated at the time of the study. From the pool of eligible SZ ($n = 114$; see Fig. 1), $n = 80$ were randomly assigned to three intervention groups, of which $n = 62$ completed the interventions and all pre- and post-intervention assessments (symptom ratings, neuropsychological assessment, magnetoencephalographic (MEG) recording). After providing written informed consent, SZ were randomly assigned (with some

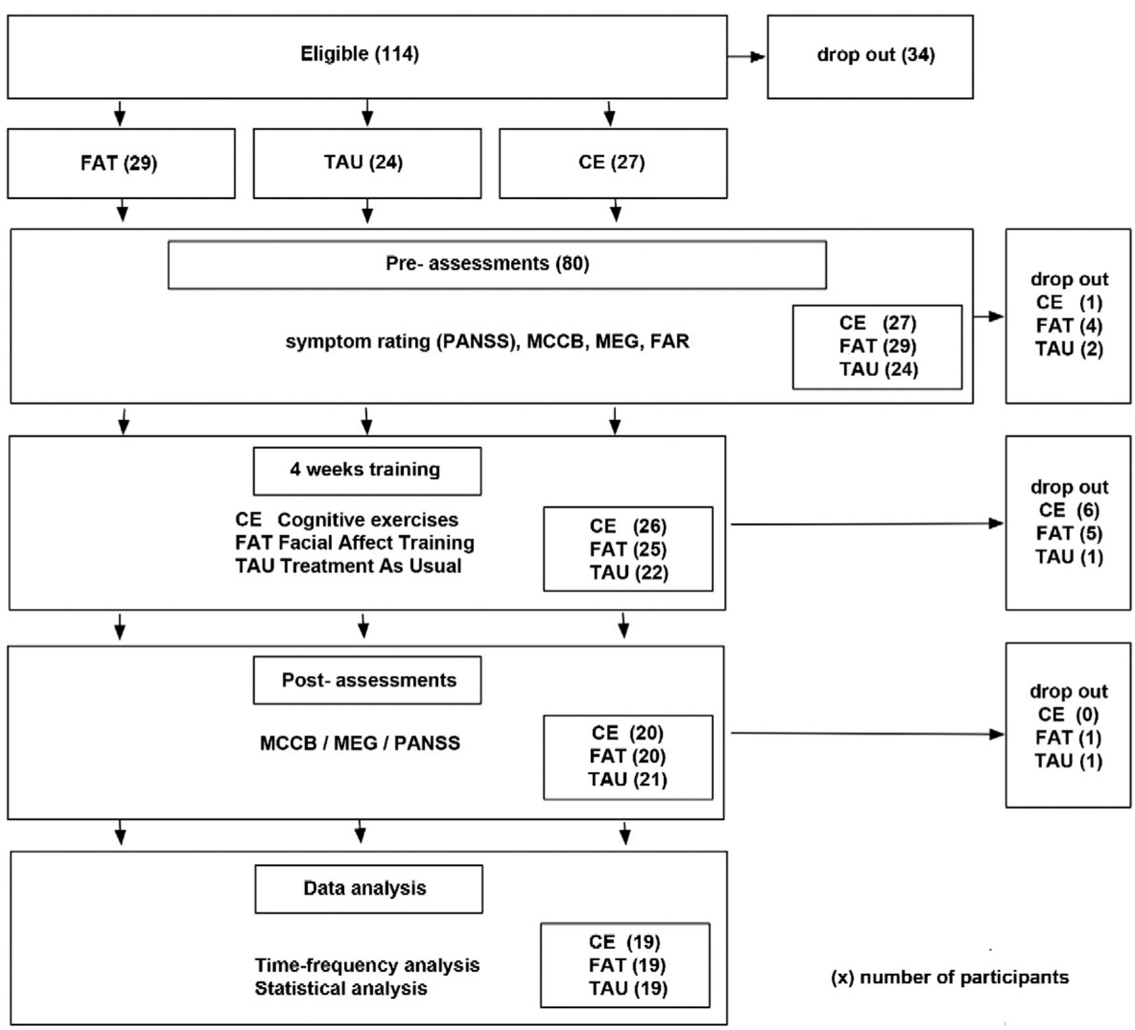

Fig. 1. Schizophrenia patient recruitment across the study protocol, following CONSORT criteria. Number of patients per study phase in brackets. Prior to MCCB and MEG assessment, patients are randomly assigned to the three intervention groups: FAT, facial affect training; CE, cognitive exercise; TAU, treatment as usual (details in Methods and materials section). FAR: Facial affect recognition criterion task (details in Methods and materials section).