rTMS at the frontopolar cortex reduces skin conductance but not heart rate: Reduced gray matter excitability in orbitofrontal regions

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Abstract

Lowered electrodermal, but not cardiovascular activity and reduced prefrontal gray matter have been observed in patients with antisocial personality disorder. The present repetitive transcranial magnetic stimulation study provides evidence for the specific involvement of the orbitofrontal regions in this pattern of autonomic functioning.
Introduction

In the February 2000 issue of the Archives, a methodologically refined study by Raine, Lencz, Bihrl, Lacasse, & Colletti demonstrated reduced prefrontal gray matter accompanied by a reduction in autonomic activity in patients with antisocial personality disorder (APD). An important additional expected observation concerned the dissociative pattern on the indexed indices of autonomic activity: a reduction in prefrontal gray matter was linked to a reduction in electrodermal, but not cardiovascular, activity. Low arousal as indexed by reduced electrodermal activity is argued to indicate insensitivity to punishment or poor fear conditionability. This results in difficulties learning to inhibit antisocial acts (Arnett, 1997; Damasio, 2000). Although it was not possible to be more specific regarding the localization of gray matter reduction within the prefrontal cortex, Raine et al. (2000) and Damasio (2000) in his commentary suggest that the orbitofrontal cortex constitutes the most likely candidate. A technique suitable for investigating the role of prefrontal brain areas in autonomic activity is repetitive transcranial magnetic stimulation (rTMS). When applied to a specific cortical area, rTMS is able to induce transient gray matter inactivity, a so-called virtual brain lesion (Pascual-Leone, Bartres-Faz, Keenan, 1999), depending on stimulation parameters.

Method

Recently we applied slow rTMS to the frontopolar cortex (FP1), targeting the left orbitofrontal cortex region, to investigate involvement of this area in autonomic arousal (Schutter, Van Honk, D’Alfonso, Postma, & De Haan, 2000). Included as dependent measures were skin conductance and heart rate, as in the study of Raine and colleagues (2000). A within-subject design was used (N = 8) in which stimulation of the left central position of the motor cortex (C3) served as the control condition. Research has shown depression of gray matter excitability after slow rTMS over the motor cortex (Chen et al., 1997).
Subjects were continuously stimulated during 20 minutes at 80% of their motor threshold with a frequency of 1 Hz.
Results

Our findings matched the pattern of autonomic functioning in APD demonstrated by Raine and co-authors (2000). Results showed that rTMS at the Fp1 position compared with rTMS at the C3 position induced a reduction in skin conductance, reaching a significance 20 minutes after stimulation \[ p < .01; 1\text{-way analysis of variance (ANOVA), } F(1,7) = 5.52 \], whereas heart rate remained unaffected \[ p > .90; 1\text{-way analysis of variance (ANOVA), } F(1,7) = 0.25 \]. Figure 4.1 shows the pattern of these results. Slow rTMS over the dorsolateral prefrontal structures modulates cardiovascular functioning, emphasizing the specificity of the FP1 stimulation (D’Alfonso et al., 1999).

Discussion

In conclusion, our pattern of autonomic arousal after slow rTMS targeting orbitofrontal regions is agreement with that of Raine et al. (2000) and thus provides converging evidence for the suggestions that prefrontal gray matter in orbitofrontal regions is reduced in APD.
References


