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Cortical plasticity, contingent negative variation, and transcendent experiences during practice of the Transcendental Meditation technique

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Abstract

This study investigated effects of transcendent experiences on contingent negative variation (CNV) amplitude, CNV rebound, and distraction effects. Three groups of age-matched subjects with few (<1 per year), more frequent (10–20 per year), or daily self-reported transcendent experiences received 31 simple RT trials (flash (S_1)/tone (S_2)/button press) followed by 31 divided-attention trials — randomly intermixed trials with or without a three-letter memory task in the S_1–S_2 interval). Late CNV amplitudes in the simple trials were smallest in the group with fewest, and largest in the group with most frequent transcendent experiences. Conversely, CNV distraction effects were largest in the group with fewest and smallest in the group with most frequent transcendent experiences (the second group's values were in the middle in each case). These data suggest culminative effects of transcendent experiences on cortical preparatory response (heightened late CNV amplitude in simple trials) and executive functioning (diminished distraction effects in letter trials).

Keywords: Contingent negative variation; CNV rebound; Distraction effects; Cortical plasticity; Transcendent experiences; Transcendental Meditation

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1. Introduction

Experience-related cortical plasticity was first identified during critical periods of development. Sensory experiences establish the appropriate orientation and interconnection of cortical receptor fields (Hubel and Weisel, 1977) and is required for mature functioning of pattern recognition abilities (von Senden, 1960). Recent research suggests that experience shapes cortical connectivity not just during critical periods in development but throughout the life span. Even in adult human and primates, sensory, motor and sub-cortical representations are continually shaped by experience (Gilbert, 1993; Donoghue, 1995; Wang et al., 1995; Buonomano and Merzenich, 1998). For instance, string players have distinctly larger cortical representations in the primary somatosensory cortex of the fingers of their left hand (the hand that forms the chords) than do non-musicians (Elbert et al., 1995).

Elbert et al. (1997) suggest that consciously performing any task regularly over time may lead to cortical reorganization. This generalization is based on research that has primarily focused on the effect of overt behavior on reorganization of sensory and motor cotius. The cortical maps for these areas are well defined. Consequently, any structural changes are (fairly) straightforward to locate and to quantify.

The quality of experience also seems to shape cortical structure. Repeated stressful experiences lead to high secretion of glucocorticoids, which are thought to lead to decreased hippocampal mass (Sapolsky, 1996). Decreased hippocampal mass is reported in depressed patients and individuals diagnosed with post-traumatic stress disorder. Stress also plays an important role in decreasing cortical blood flow and adversely affecting behavior (Amen and Carmichael, 1997).

Our research has focused on the effects of transcendent experiences during Transcendental Meditation® (TM®) practice[1] on brain functioning. Transcendent experiences during TM practice are phenomenologically and physiologically distinct from other waking eyes-closed experiences and occur many times in each TM session. These experiences are subjectively characterized by 'silence' and the 'loss of boundaries of time, space and body sense' (Travis and Pearson, 2000; see also Maharishi, 1963). Time, space and body sense are the framework that give meaning to waking experiences (Velmans, 1993). During transcendent experiences, the very framework of ordinary waking experience is absent. In addition, these transcendent experiences are physiologically distinct from other eyes-closed states. Transcendent experiences are characterized by apneustic breathing up to a period of 40 s, with autonomic orienting at their onset (Travis and Wallace, 1997). Apneustic breathing has not been reported in non-clinical populations and, even in clinical populations, never for longer than 4–6 s (Plum and Posner, 1980). In addition, high amplitude global alpha activity is reported during transcendent experiences suggesting stable thalamo-cortical oscillations during this state (Travis and Wallace, 1999). Based on

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