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Association of posterior EEG alpha with prioritization of religion or spirituality: A replication and extension at 20-year follow-up

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ABSTRACT

A prior report (Tenke et al., 2013 Biol. Psychol. 94:426–432) found that participants who rated religion or spirituality (R/S) highly important had greater posterior alpha after 10 years compared to those who did not. Participants who subsequently lowered their rating also had prominent alpha, while those who increased their rating did not. Here we report EEG findings 20 years after initial assessment. Clinical evaluations and R/S ratings were obtained from 73 (52 new) participants in a longitudinal study of family risk for depression. Frequency PCA of current source density transformed EEG concisely quantified posterior alpha. Those who initially rated R/S as highly important had greater alpha compared to those who did not, even if their R/S rating later increased. Furthermore, changes in religious denomination were associated with decreased alpha. Results suggest the possibility of a critical stage in the ontogenesis of R/S that is linked to posterior resting alpha.

1. Introduction

Prominent EEG alpha, which is typically obtained from surface potentials measured at scalp, has been associated with better pharmacologic treatment outcomes for clinical depression (Bruder et al., 2008; Tenke et al., 2011; Ulrich, Renfordt, & Frick, 1986). However, systematic comparisons of resting alpha for reference-dependent (nose, average) EEG with reference-free surface Laplacian or current source density (CSD) transformations have demonstrated considerable pitfalls for spectra derived from surface potentials (SP) that are effectively counteracted by CSD (Kayser & Tenke, 2006a, 2006b, 2015a, 2015b; Tenke & Kayser, 2005, 2015). Compared to SP spectra, CSD spectra not only have sharper topographies (Tenke et al., 2015) but also provide the more consistent and appropriate representation of distributed posterior generators in simulation (Tenke & Kayser, 2015), and thereby yield more reliable estimates of alpha activity at scalp. We found that overall posterior CSD alpha during rest is strongly correlated with prestimulus alpha in a novelty oddball task (Tenke et al., 2015), suggesting that posterior alpha may reflect a stable individual trait that cuts across task boundaries or experimental protocols. Even though posterior alpha has been associated with a family history of MDD (Bruder et al., 2005), it remains to be determined to what extent posterior alpha is (1) related to a vulnerability to depression, (2) a predictor of treatment outcome, or (3) an initial vulnerability that is linked to a subsequent propensity toward recovery.

The personal importance of religion or spirituality (R/S) is associated with protection against depression (Kendler, Gardner, & Prescott, 1997; Miller, Warner, Wickramaratne, & Weissman, 1997; Smith, McCullough, & Poll, 2003), and particularly against recurrence of depression (Miller et al., 2012), which is consistent with an acquired resilience following initial vulnerability to MDD. We previously observed that individuals who differed by personal importance of R/S also differed in the prominence of EEG alpha (Tenke et al., 2013) suggesting that prominent alpha may be a marker for a cluster of related biological, affective and hedonic pre-

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dispositions. Those who rated R/S as important at an initial test session had greater EEG alpha at a subsequent assessment ten years later than those who did not (Tenke et al., 2013). Our initial considerations led us to hypothesize that EEG alpha might increase in amplitude as a result of R/S importance. In this scenario, alpha enhancement could be a result of meditation or prayer (Aftanas & Golosheykin, 2005; Cahn & Polich, 2006; Chiesa & Serretti, 2010), stress reduction (Flannelly, Koenig, Galek, & Ellison, 2007; Koenig, 2009; Meisenhelder & Marcum, 2009; Stein et al., 2004), or other practices that might accompany R/S. However, our EEG findings were inconsistent with this interpretation, because we observed neither the enhancement of alpha with newly acquired R/S importance, nor its disappearance when the valuation of R/S decreased.

Another conclusion that might be drawn from the data is that EEG alpha could be a marker for the ontogenesis and time course of a disposition toward R/S, rather than either a result or correlate of R/S itself. However, this simpler conclusion is at best preliminary, because the data were limited to changes in R/S Importance assessed at the same time point at which the EEG was measured. It was thereby possible that hypothesized changes in EEG alpha simply required additional time to develop. Conversely, prominent alpha could itself be the trait that protects against MDD and/or is predictive of a good treatment response, and that individuals with this trait disproportionately value R/S highly. Apart from these conceptual considerations, an additional limitation of the original study was a limited spatial sampling of the alpha topography with a low-density EEG montage (i.e., 13 sites), which might have underrepresented the complete posterior generator topography of alpha.

The purpose of the present study was to replicate and extend the previous findings on R/S and EEG alpha. After an additional ten year interval, a larger sample of participants were administered two additional R/S assessments and an EEG recording using a higher density montage (i.e., 72 sites) to better captures the generator topography of EEG alpha. The additional assessments over time allowed us to distinguish between two competing hypotheses: (1) those who were initially identified as having high R/S importance would continue to show high alpha, regardless of intervening R/S reports (i.e. the initial R/S distinguished between individuals differing in the trait of EEG alpha); or (2) individuals who increased, and subsequently maintained, their self-reports of R/S importance would also develop high amplitude alpha (i.e. prominent alpha is associated with persistent R/S importance).

2. Methods

2.1. Participants

This report included seventy-three adult participants (43 female) who had EEG recordings at year 30 (T30; mean age 43.25 yrs ± 10.2) as part of a multiwave three-generation longitudinal study of individuals at high and low risk for major depression based on family history (for details of methods see Weissman, Warner, Wickramaratne, Moreau, & Olfso, 1997; Weissman et al., 2005; Weissman et al., 2006; Weissman et al., 2016a, 2016b). Twenty-one participants were also included in our previous report of the findings at T20 (Tenke et al., 2013), while the remaining 53 only had EEG data at T30. In the original wave of the study (Weissman et al., 1997), probands with moderate to severe major depressive disorder were selected from outpatient clinics for the psychopharmacologic treatment of mood disorders, and non-depressed, demographically-matched control participants were selected from an epidemiologic sample of adults with no psychiatric history from the same community. The sample was recruited from an urban setting (greater New Haven area, Connecticut, US), and consisted of Caucasian and working or middle class individuals.

Table 1
Lifetime MDD by Parental MDD.

	Lifetime MDD		
	No	Yes	
No MDD Parent	18	9	27
MDD Parent	13	33	46
	31	42	73

Fisher's exact test: p = .003.

Table 2
Religious Denomination.

	T10	T30
Catholic	47	37
Protestant	10	5
Jewish	4	4
Buddhist/Hindu/Islam	–	1
Personal Religious	2	13
Agnostic/Atheist	4	8
Other	–	5
	N = 67	*N* = 73

Clinical assessments were conducted by independent interviewers who were blind to the participant's previous clinical history (personal or family).

Assessments were from waves at years 10 (T10; beginning 1992), 20 (T20; beginning 2002), 25 (T25) and 30 (T30). All procedures had been approved by the institutional review boards at Yale University and at Columbia University/New York State Psychiatric Institute. All participants gave written informed consent. As indicated in Table 1, 46 participants who were at high risk due to parental depression were also characterized by significantly greater lifetime rates of MDD compared to those in the low risk group (Fisher exact test, p = .003).

2.2. Religiosity or spirituality

Assessments included participant responses on religious denomination and attendance ("never" to "once a week or more" on a 5-point scale) at T10, T20, T25 and T30. As indicated in Table 2, participants were predominantly Roman Catholic (70%) when first assessed at T10, which dropped to 51% by T30. A total of 44% of the participants reported a change in religious denomination during this time span. R/S importance was also assessed with the question "How important is religion or spirituality to you?" Response option ranged from 1 to 4 ("not important at all," "slightly important," "moderately important," "very important"). This question showed robust correlations with the widely-used Fetzer Institute full-scale measure of personal spirituality (Idler et al., 2003). The terms "religion" and "spirituality" were both included in this question because they are frequently linked together in studies on health (Koenig, McCullough, & Larson, 2001; Larson & Larson, 2003; Tsuang, Williams, Simpson, & Lyons, 2002). Participant responses were dichotomized as "very important" vs. all other responses based on prior findings (Miller et al., 1997, 2012; Tenke et al., 2013), and will hereafter be referred to as "Important" and "Not Important" for sake of brevity.

Table 3 shows the R/S/Importance classification of all participants at assessment time T10 and the later assessments, indicating subgroup classifications (italics) and corresponding cell sizes for the resulting subgroups and the cross-tabulation marginals (row and column sums). Only 21 participants provided EEG at wave 20 (ns in parentheses). Of the 73 in the present sample, 14 were categorized as "Important" at T10. All except 4 of these changed their prioritization at a later assessment (i.e., they "*Migrated Out*" of their prioritization). However, the total number who prioritized