



Resting posterior versus anterior theta power: exploring the relationship to approach and withdrawal traits.

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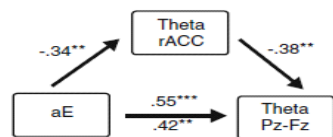


Abstract

Resting posterior versus anterior (PZ-FZ) theta band activity has been examined as a putative correlate of the dopaminergic core of extraversion and an indication of theta arising from the Anterior Cingulate Cortex (ACC). Electroencephalographic studies of approach motivation and agentic extroversion (aE) have found that more relative posterior theta compared to midline frontal theta is associated with higher levels of aE as well as higher behavioral activation (BAS) scores (Chavanon, Wacker, & Stemmler, 2011). The present study thus investigated the BAS-resting theta association in a sample of 48 male participants, screened to ensure no current or past history of DSM-IV Axis I pathology. Contrary to expectation, significant relationships with measures of anxiety and negative affect (behavioral inhibition, worry, trait anxiety and negative affect) revealed participants with higher anxiety or negative affect showed more relative posterior theta compared to those who reported lower anxiety and negative affect. No significant relationship was found for BAS or its subscales with posterior versus anterior theta scores. These findings were unexpected given previous findings of BAS and aE's association to relatively greater posterior theta, but suggest the relationship of affective/motivational psychological constructs and resting midfrontal theta activity may be more complex than extant research suggests.

Introduction

- Recent research has linked agentic extraversion to the dopaminergic system and activity in the ACC (Chavanon et al., 2011).
- Frontal midline theta is thought to be generated by or at least near the anterior cingulate cortex (Asada, Fukuda, Tsunoda, Yamaguchi, & Tonoike, 1999; Ishii et al. 1999). Generators of posterior theta are not as well researched but believed to be distinct from that of frontal theta (Chavanon et al., 2011). Therefore it has been proposed that an index of posterior minus anterior theta power scores may capture meaningful variance related to individual differences in traits such as aE and BAS.
- Frontal midline theta has been linked with myriad mental processes from concentration, emotional processing and mental effort (Aftanas & Golosheikine, 2001, Jensen & Tesche, 2002). Emerging research has focused on lower frequency activity in the delta and theta bands and an association to aspects of behavioral activation (Wacker & Gatt, 2010; Chavanon, et al., 2011).
- Chavanon et al. (2011) found a negative relationship between rACC activity and PZ-FZ scores. Greater relative PZ compared to FZ theta was associated with less rACC and higher aE activity, and less rACC activity was associated with greater relative PZ compared to FZ theta power.



From Chavanon, Wacker, & Stemmler (2011)

- The present study sought to investigate this relationship further with a comparable sample and methodology. Therefore this study, like Chavanon et al. (2011), utilized an average reference scheme in a male sample free of any current or past psychopathology.

Method

Subjects

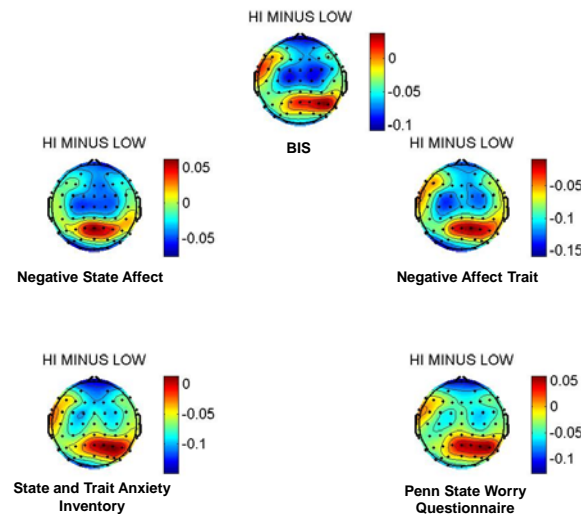
- 48 male participants were screened using a structured clinical interview and free of any current or past Axis I pathology.

Procedure

- EEG data Collection and reduction:
 - Participants visited the lab on 4 separate days within a 2 week window.
 - Each session comprised 2 eight minute resting baselines consisting of eyes open and eyes closed recording periods.
 - Data were recorded using a 64 channel EEG cap and sampled at 1000 hz with a 0-200hz bandpass filter.
 - Data were referenced online to a site immediately posterior to CZ and referenced offline to averaged reference (as Chavanon et al., 2011).
 - Once collected, data were visually inspected for artifacts. Blinks were rejected from the resultant data using a blink rejection algorithm that rejects segments with ocular activity exceeding a +/- 75 microvolt threshold in the ocular channel.
 - Data were epoched into 2.048 second blocks that overlapped by 1.5 seconds. A Fast Fourier Transform was used to extract spectral power, and theta band activity (4-7 hz) was examined. Posterior versus anterior index was computed using natural log transformed PZ power minus log transformed FZ power (ln[PZ]-ln[FZ]) as was the case in Chavanon et al. (2011).

Results

- Across measures tapping negative affect and withdrawal behaviors a consistent pattern of more relative posterior than anterior theta emerged. This is inconsistent with previous studies where this pattern of more relative posterior theta was related to agentic extroversion and to BAS.



Discussion

- Results of the current examination indicate that less relative frontal theta is present across widely used measures tapping anxiety, negative affect, and withdrawal behaviors. This is generally unexpected given that this pattern was previously found to be associated with agentic extroversion and with behavioral activation.
- Frontal theta measured at FZ could be the result of heterogeneous sources including both the dorsal and rostral ACC. These sources may combine in various proportions at the surface. Chavanon et al. (2011) report similar correlations between dorsal ACC activity and questionnaires related to extraversion as they do with rACC activity. However, the correlation of dorsal ACC with PZ-FZ theta scores is substantially smaller than that of rACC (Chavanon et al., 2011).
- The present study did not measure aE directly, but did assess related constructs. Nevertheless the findings were opposite than expected with these measures
 - BAS drive may be the closest proxy for aE the present measured. However, no significant relationship was found to PZ-FZ theta scores
- There are several methodological differences between this study and previous work. The present study's resting state consisted of eyes open and eyes closed recording periods while that of Chavanon et al. (2011) consisted of five 1 minute eyes open periods.
- Theta band activity has been shown to be influenced by eye condition and this may play a role in differing results (Barry, Clarke, Johnstone, Magee, Rushby, 2007). However, analyses including only data derived from the eyes open resting segments produced largely non significant results. Where significant the results were consistent with the analyses from the data derived from the full resting period, suggesting that this procedural difference cannot explain the discrepancies in findings between the present study and that of Chavanon et al. (2011).
- The general consistency of the pattern of results within this study suggests that examining midline theta activity and emotional traits maybe worthy of further study.

References

Aftanas, L. I., & Golosheikine, S. A. (2001). Human anterior and frontal midline theta and lower alpha reflect emotionally positive state and internalized attention: high-resolution EEG investigation of meditation. *Neurosci Lett*, 310(1), 57-60.

Asada, H., Fukuda, Y., Tsunoda, S., Yamaguchi, M., & Tonoike, M. (1999). Frontal midline theta rhythms reflect alternative activation of prefrontal cortex and anterior cingulate cortex in humans. *Neurosci Lett*, 274(1), 29-32.

Barry, R. J., Clarke, A. R., Johnstone, S. J., Magee, C. A., & Rushby, J. A. (2007). EEG differences between eyes-closed and eyes-open resting conditions. *Clin Neurophysiol*, 118(12), 2765-2773.

Chavanon, M. L., Wacker, J., & Stemmler, G. Rostral anterior cingulate activity generates posterior versus anterior theta activity linked to agentic extraversion. *Cogn Affect Behav Neurosci*, 11(2), 172-185.

Ishii, R., Shinosaki, K., Ukai, S., Inouye, T., Ishihara, T., Yoshimine, T., et al. (1999). Medial prefrontal cortex generates frontal midline theta rhythm. *Neuroreport*, 10(4), 675-679.

Jensen, O., & Tesche, C. D. (2002). Frontal theta activity in humans increases with memory load in a working memory task. *Eur J Neurosci*, 15(8), 1395-1399.

Wacker, J., & Gatt, J. M. Resting posterior versus frontal delta/theta EEG activity is associated with extraversion and the COMT VAL(158)MET polymorphism. *Neurosci Lett*, 478(2), 88-92.

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