MEDIOFRONTAL THETA AND PERSONALITY TRAITS

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Abstract

- ❑ ERN trait have been hypothesized to be a marker for anxiety disorders
  - ❑ Larger ERNs linked to: High general anxiety and worry (Hajcak et al., 2003), Negative affect (Hajcak et al., 2004;Luu et al., 2000), Labile personality traits (Pailing & Segalowitz, 2004)

- ❑ The relationship between these personality traits and the underlying neurobiology of the ERN has not been well-defined.

- ❑ ERN reflects mediofrontal theta band power enhancement and phase consistency.
  - ❑ ERN and FRN have been shown to reflect a degree of theta phase consistency and power enhancement over the medial frontal cortex (Cavanagh et al., 2009)

- ❑ **Purpose:** to characterize the relationship between anxiety-related personality traits (neuroticism, punishment sensitivity, negative affect, and worry) and midline frontal theta responses as well as ERN amplitudes.

- ❑ **Methods:** Participants completed three different tasks, each with varying degrees of stimulus and response conflict: perceptual oddball and simple motor responses, probabilistic reinforcement learning, and cued conflict performance on a Simon task.

- ❑ **Hypothesis:** It was predicted that only motivationally relevant events would yield a relationship between theta and personality traits, specifically responses to incongruent, error, suboptimal, high conflict and error trials.

- ❑ **Results:**
  - ❑ Direct correlations between the aggregated z score personality measures and ERP amplitudes for sub-optimal choices (p<.05) but not errors or high conflict trials.
  - ❑ No direct correlations between theta values and z-score of personality measures.
  - ❑ Permutation tests revealed that pre-response theta power on cued high conflict trials, incongruent trials and error trials, as well as high conflict conditions on the PL task were significantly related to negative affective personality traits.

- ❑ **Conclusion:** Time-frequency representations of mediofrontal theta can reveal more about the EEG-personality relationship that traditional ERP methods.

Method

Participants
- ❑ 40 college students (7 females) at the University of Arizona
  - ❑ Age18-22 (M=19.18, SD=1.13)
  - ❑ Free of past head trauma or seizures and current psychoactive medication use.
- ❑ EEG was recorded continuously using 64-channel EEG cap referenced to computer-averaged-mastoids.

Questionnaires
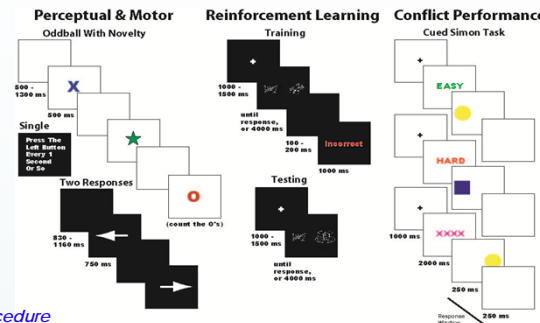- ❑ Aggregate measure of negative and anxious affect (BIS, PSWQ, NEO-N ,PANAS-NA) which were all significantly intercorrelated (r's .73 : .83, p's <.01).

Tasks
- ❑ Perception and Motor Tasks: Oddball with novelty
- ❑ Conflict Performance: Cued Simon Task
- ❑ Probabilistic Reinforcement Learning

Method (Cont'd)

Fig. 1 Three tasks

Procedure
- ❑ Complete questionnaires and demographic information.
- ❑ EEG cap was applied and participants rested quietly for six minutes while resting EEG was recorded.
- ❑ Participants completed three different sets of tasks in a randomized counter-balanced order.

> **QUESTION: Are negative affect and anxiety-related personality traits associated with ERN amplitudes and midline frontal theta responses?**

Electrophysiological Recording and Processing
- ❑ ERPs were created for standard (.5-15 Hz) and theta (4-8Hz) frequency bands.
- ❑ Trough-to-peak measurements were used. Larger trough-to-peak values reflecting larger negative voltage potentials.
  - ❑ Cue-locked (FRN) were measured at 200-320 ms.
  - ❑ Response-locked (ERN) were measured at 0-120 ms.

Results

Correlations
- ❑There were direct correlations between the aggregated z score personality measures and ERP amplitudes for sub-optimal choices (r=.330, p<.038).
- ❑No significant correlation between aggregate Negative affect scores and errors or high conflict trials, although some individual personality measures showed predicted relationships.
- ❑No significant correlation between the aggregated z score personality measures and theta traditional measures.
- ❑In general, theta scores significantly correlated to the corresponding ERN measure in the range of r= .07 to .424.

Table. 1 ERN, Theta, and Z aggregated Negative Affect Correlations

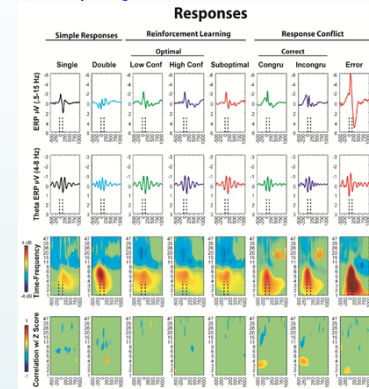|			Theta		
	ZAggNA	Suboptimal	Hi Conflict	Error	Incongruent
ZAggNA	1	-.157	-.163	-.027	-.085
Suboptimal	0.330*	.077	.133	.237	.318*
Hi Conflict	.178	.174	.202	.147	.207
Error	.114	.189	.133	0.426**	0.549**
Incongruent	.204	-.056	-.019	0.617**	0.411**

Results (Cont'd)

ERNs and Theta
- ❑The correlations suggest that the ERN has a stronger relationship than theta to negative affect and anxiety related personality traits.

- ❑Permutation tests revealed that pre-response theta power on cued high conflict trials, incongruent trials and error trials, as well as high conflict conditions on the PL task were significantly related to negative affective personality traits.

Fig. 2 ERP, Theta, Time Frequency, and Correlation with Z-score for response-locked EEG

Discussion

- ❑ Negative affect showed some predicted relationships with ERN and theta responses, with permutation tests revealing more relationships between mid-frontal theta power and negative affective personality traits.

- ❑ Specifically, pre-response relationships with incongruent, high conflict, and error trials were present even when these patterns were absent with post-response ERP or theta power measures.

- ❑ These findings suggest that negative affect is indeed an important moderator of these mid-frontal signals.

- ❑ The use of more sensitive techniques like time-frequency decomposition and permutation tests can be more advantageous than traditional EEG analysis methods.

References

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