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# Spirituality and Error Processing

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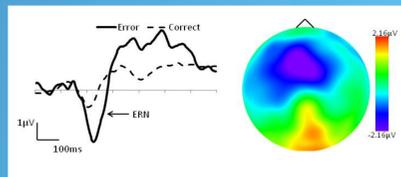


## INTRODUCTION

### Performance Monitoring and Empathy

- Hundreds of articles have been published in psychology journals investigating spirituality and its uses in therapy and as a coping mechanism. However little research has been done on the effect of spirituality and neurological processes.
- Inzlicht et. al. (2009) asserted that both belief in God and high religious zeal were correlated with smaller ERN amplitudes. However in Inzlicht's study only those who were highly zealous spiritually and if the participants believed in God. Nothing about the components of spirituality were examined.
- In order to fully assess the components of spirituality the Spirituality Assessment Inventory (SAI) was administered and the various subscales analyzed.

### Error-Related Negativity/Post-error Positivity



- Error related negativity (ERN) is an event related potential(ERP) characterized by the increased negative amplitude 100 ms after an incorrect response.
- The ERN is believed to reflect error processing through the error monitoring of the anterior cingulate cortex.

### Hypothesis

- We suggest that individual components of spirituality will significantly correlate with the ERN more than the holistic belief in God.

## METHODS

### Task

- Eriksen Flanker Task**
  - Direction indication only
  - 50% congruent (e.g., <<<<<<)
  - 50% incongruent (e.g., >>>><<)
  - 3 blocks of 300 trials each



### EEG Acquisition

- 128 channel sensor net
- Horizontal and vertical EOG
- Cz referenced
- .10-100Hz bandpass
- 250Hz sampling rate
- Impedance < 50 kΩ
- Average re-referenced



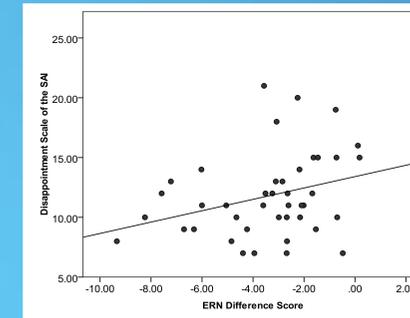
### ERP Reduction

- BESA artifact/EOG correction
- 15Hz low-pass filter
- ERN: Frontocentral electrode sites
- Epochs: -200 – 500ms
- 200ms baseline correction
- ERN: max. negative peak (0-100ms)

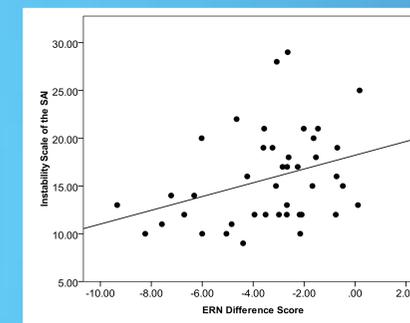
### Statistical Analysis

- Differences between congruent and incongruent trials were examined using within subjects paired-samples *t*-tests.
- Pearson's product-moment correlations were utilized to determine the relationship between empathy and behavioral indices of error (i.e., post-error slowing, ERN, and Pe).
- Subsequent partial correlations controlled for the potential contributions of negative affect to the relationship between empathy and indices of error processing.
- Multiple regression analyses with the error-trial minus correct-trial difference score as the dependent variable were used to determine the unique correlates of empathy and ERN amplitude.

## RESULTS



- ERN amplitude is negatively correlated with the Disappointment subscale of the SAI ( $r = .308^*$ ,  $p < .05$ ).



- There was an even stronger relationship between the Instability subscale of the SAI and the ERN. ( $r = .335^*$ ,  $p < .05$ ).

- No correlation was found between the Grandiosity, Impression Management, Awareness, or Realistic Acceptance ( $r = -.170$ ,  $r = -.065$ ,  $r = -.078$ ,  $r = -.098$  respectively).

## PARTICIPANTS

42 Healthy participants were tested in this study (21 female).

### Demographics and Summary Information

	Mean (STD)
Age	26.342 (7.63)
Education	15.64 (1.50)
BDI 2*	5.76 (4.62)
STAI State**	31.50 (8.96)
STAI Trait**	35.00 (7.90)
SAI Aware	64.86 (12.67)
SAI RealAccept	28.48 (7.31)
SAI Disappoint	11.79 (3.51)
SAI Grandiosity	11.64 (3.18)
SAI Instability	15.76 (4.89)
SAI ImpressMgmt	15.21 (3.23)

\*Beck Depression Inventory 2nd edition

\*\*State Trait Anxiety Inventory

## SUMMARY TABLE

	ERN Diff	SAI Aware	SAI RealAccept	SAI Disappoint	SAI Grandiosity	SAI Instability	SAI ImpressMgmt	BDI II	STAI State	STAI Trait
ERN Diff	1									
SAI Aware	-0.078	1								
SAI RealAccept	-0.098	0.236	1							
SAI Disappoint	0.308*	-0.041	0.02	1						
SAI Grandiosity	-0.17	-0.052	-0.14	0.109	1					
SAI Instability	0.335*	-0.172	-0.019	0.399**	0.208	1				
SAI ImpressMgmt	-0.065	0.513**	0.287	-0.082	-0.107	-0.148	1			
BDI II	0.256	0.143	-0.127	-0.018	0.081	0.384*	-0.033	1		
STAI State	0.12	-0.084	-0.215	0.255	-0.006	0.509**	-0.151	0.600**	1	
STAI Trait	0.188	-0.067	-0.11	0.327*	0.072	0.83**	-0.016	0.555**	0.772**	1

\* Correlation is significant at the 0.05 level (2-tailed)

\*\* Correlation is significant at the 0.01 level (2-tailed)

## CONCLUSIONS

- In the first analysis no relationship was found between the positive spirituality subscales, e.g., Realistic Acceptance, Awareness, Impression Management, and smaller ERN amplitudes.
- Two of the negative subscales of the SAI, Disappointment and Instability, demonstrated correlations with smaller ERN amplitudes. The third, Grandiosity, did not exhibit a relationship with ERN amplitudes in any significant way.
- The Disappointment and Instability subscales are both associated with a lower sense of self-efficacy or internal control. The positive subscales are more associated with a greater sense of self-efficacy and resiliency to negative outcomes. Grandiosity as a subscale measures the degree to which an individual believes they can influence God, implying that higher grandiosity scores correlate with a greater sense of control or power.

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