Alpha Response Reveals Attention Abnormalities in Psychopathy: Supplemental Materials

Supplemental Methods

Participants

Participants were recruited from the New Haven community. Nationally, New Haven ranks in the 95th percentile for crime; on average, 364 crimes are committed per square mile, compared to the national median of 31.9 (http://www.neighborhoodscout.com/ct/new-haven/crime/, accessed on 02/20/2018). The rate of violent crime is 9.42 (per 1,000 residents), compared to a statewide rate of 2.27 and a national median of 4.00.

A prescreen interview was completed to exclude individuals who had a history of schizophrenia, bipolar disorder, or psychosis, not otherwise specified; a family history of psychosis; or a history of medical problems (e.g., uncorrectable auditory or visual deficits; head injury with loss of consciousness greater than 30 minutes) that may have impacted their comprehension of the materials or performance on the task. In the first session, participants provided written informed consent if 18 years of age or older, and assent/parental consent if under 18 years of age, in line with the procedures set forth by the Yale University Human Investigation Committee. Then, participants completed the Shipley Institute of Living Scale (Zachary, 1986), which provides an estimate of IQ and was used to exclude anyone with an IQ below 70, and completed a self-report measure of psychopathy and behavior. During the second session, participants completed the experimental task while neural responses were recorded using EEG. Participants were paid $30 per session.

Psychopathy Measure

Youth Psychopathic Traits Inventory (YPI; Andershed, Kerr, Stattin, & Levander, 2002). The YPI is a 50-item self-report measure that assesses psychopathy among youth and

young adults. Items from the measure make up the following ten subscales: dishonest charm (e.g., “I have the ability to con people by using my charm and smile”), grandiosity (e.g., “I'm better than everyone on almost everything”), lying (e.g., “Sometimes I lie for no reason, other than because it's fun”), manipulation (e.g., “I can make people believe almost anything”), remorselessness (e.g., “To feel guilt and regret when you have done something wrong is a waste of time”), unemotionality (e.g., “I usually feel calm when other people are scared”), callousness (e.g., “I think that crying is a sign of weakness, even if no one sees you”), thrill seeking (e.g., “I like to be where exciting things happen”), impulsiveness (e.g., “I consider myself as a pretty impulsive person”), and irresponsibility (e.g., “I have often been late to work or classes in school”). Participants respond on a 4-point Likert scale ranging from “does not apply at all” to “applies very well.” Several items in the scale are reverse-coded so that a higher total score indicates more psychopathic traits.

Consistent with YPI total scores reported by prior studies examining at-risk community samples (M = 96.2, SD = 19.2; Neumann & Pardini, 2014), the mean YPI total score for the present sample (M = 92.7, SD = 18.6) falls between mean scores found in unselected adolescent samples (M = 87.7, SD = 21.1; Larsson et al., 2006) and incarcerated juvenile offender samples (M = 133.7, SD = 27.2; Skeem and Cauffman, 2003). Moreover, the range of YPI total scores found in the current sample (minimum = 59, maximum = 145) is comparable to the range of scores found in prior studies examining samples at risk for antisocial behavior and psychopathy (minimum = 59, maximum = 150; Neumann & Pardini, 2014).

In the current sample, the YPI exhibited high internal consistency (i.e., reliability; Cronbach’s α = .92). Additionally, in the current sample, YPI showed good convergent validity, with higher YPI scores positively correlating with higher rates of all impulsive behaviors

throughout the life course as measured by the Risky, Impulsive, and Self-destructive behavior Questionnaire (Sadeh & Baskin-Sommers, 2016) total score (r = .346, p = .006), higher rates of drug and alcohol abuse (as measured by the Drug Screening Questionnaire [DAST; Gavin, Ross, & Skinner, 1989] total score; r = .297, p = .020; and Alcohol Use Disorders Identification Test [AUDIT; Saunders et al., 1993] total score; r = .413, p = .001, respectively), and higher rates of sensation seeking as measured by the Sensation Seeking Scale (SSS; Hoyle, Stephenson, Palmgreen, Lorch, & Donohew, 2002; Zuckerman, Eysenck, & Eysenck, 1978) total score (r = .254, p = .049).

Psychophysiological Recording and Preprocessing

EEG was recorded throughout the experiment from 128 Ag/AgCl electrodes embedded within a Hydrocel Geodesic sensor net, using NetStation v.4.2 software (Electrical Geodesics, Incorporated [EGI]) and EGI high-impedance amplifiers, sampled at 1000 Hz (.1 Hz high-pass, 100 Hz low-pass). All electrodes were referenced to Cz for recording. Electrooculogram (EOG) was recorded above and below the left eye (VEOG) in line with the pupil. At the start of the experimental session, impedance for each electrode was below 40 KΩ.

EEG data were preprocessed using the Physbox plugin (Curtin, 2011) within the EEGLAB toolbox (Delorme and Makeig, 2004) in MATLAB. Data were re-referenced to an average reference of all electrodes and digitally filtered offline with Butterworth band-pass filter, with the low-pass filter set at 0.5Hz and the high-pass filter set at 45Hz. Eyeblink artifacts were identified and removed using a regression-based procedure (Semlitsch et al., 1986). Data were segmented around stimulus onset (0 to 800ms) and corrected to a 200ms baseline. Trials with EEG voltages beyond ±75 μV were discarded from further analyses.

Supplemental Results and Discussion

Behavioral Performance

Consistent with previous research (Esterman et al., 2013), participants committed significantly more commission errors (i.e., responding inappropriately during NoGo trials; M = 40.54% of NoGo trials, SD = 15.65%)[1] than omission errors (i.e., failing to respond during Go Trials; M = 24.24% of Go trials, SD = 10.38%), $t(60) = 8.069$, $p < .001$. There was no direct relationship between psychopathy and task accuracy ($F[1,59] = 1.350$, $p = .250$, $\eta_p^2 = .022$, 90% CI [.000, .115]). These results are consistent with prior research demonstrating that psychopathy is associated with intact behavioral, but atypical neural responses during Go/NoGo tasks (Kiehl, Smith, Hare, & Liddle, 2000; Munro et al., 2007). However, a mediation model with YPI total score as the independent variable, parietooccipital alpha suppression and NoGo-central alpha activity as multiple mediators, and behavioral inhibition during NoGo trials as the dependent variable, indicated a significant indirect effect via parietooccipital alpha suppression (i.e., higher psychopathy was associated with higher accuracy via greater parietooccipital alpha suppression; $\beta = .080$, $SE = .0445$, 95% CI [0.019, .199]). This suggests that, while psychopathy does not directly impact task performance, for individuals who are high on psychopathy, parietooccipital alpha responses play a key role in task performance, with higher parietooccipital alpha suppression leading to better motor control during NoGo trials.

YPI Factor Scores

When including YPI's three factor scores (z-scored) as simultaneous, continuous between-subject factors in a repeated measures GLM examining the parietooccipital alpha responses, none of the YPI factors significantly impacted the alpha response. Neither YPI's

[1] Accuracy for NoGo trials was significantly greater than chance, $t(60) = 4.720$, $p < .001$.

interpersonal factor, $F(1,57) = 1.068$, $p = .306$, YPI's affective factor, $F(1,57) = .573$, $p = .452$, nor YPI's behavioral factor, $F(1,57) = .060$, $p = .807$, significantly interacted with trial type (i.e., Go vs. NoGo). Additionally, there was not a significant main effect of YPI's interpersonal factor $F(1,57) = 1.442$, $p = .235$, YPI's affective factor, $F(1,57) = .474$, $p = .494$, or YPI's behavioral factor $F(1,57) = 1.109$, $p = .297$.

When YPI's three factor scores (z-scored) were included as simultaneous, continuous between-subject factors in a GLM examining the central alpha response, neither YPI's interpersonal factor, $F(1,57) = .009$, $p = .926$, YPI's affective factor, $F(1,57) = .3.371$, $p = .072$, nor YPI's behavioral factor, $F(1,57) = .027$, $p = .871$ significantly interacted with trial type. Also, there was no main effect of YPI's interpersonal factor $F(1,57) = 1.343$, $p = .251$, YPI's affective factor $F(1,57) = 3.958$, $p = .051$, or YPI's behavioral factor $F(1,57) = .020$, $p = .888$.

Taken together, these findings suggest that psychopathy, as a unitary construct, is associated with atypical neural responding during a sustained attention task; however, no specific subcomponent of psychopathy appears to be driving this result. Consistent with the current findings, a large portion of recent research examining attention abnormalities in psychopathy demonstrated that psychopathy, as a unitary construct, is associated with abnormal allocation of attention (Baskin-Sommers, Curtin, & Newman, 2011; 2013; Rodman et al., 2016; Tillem et al., 2016), rather than specific subcomponent factors.

Supplemental Tables

Supplemental Table 1. Sample Characteristics and Task Performance

Variable	N	Min	Max	Mean	Std. Deviation
Demographics					
Age	61	14.00	24.00	19.52	3.05
Sex	61				
Male	44				
Female	17				
Race	61				
White	7				
Black	44				
American Indian	1				
Mixed	9				
Handedness	61				
Right-Handed	55				
Left-Handed	6				
Shipley Total Estimated IQ	61	72	116	97.08	9.34
Individual Differences					
YPI Total Score	61	59	145	92.69	18.56
Task Variables					
Overall Accuracy	61	.51	.96	.74	.10
City Accuracy	61	.49	.97	.76	.10
Mountain Accuracy	61	.27	.90	.59	.16
Overall Reaction Time (s)	61	.41	.67	.55	.06
Correct Reaction Time (s)	61	.41	.67	.56	.06
Incorrect Reaction Time (s)	61	.36	.64	.48	.07

Supplemental Table 2. Zero-Order Correlations (n = 61)

	Correlations									
Variable	1	2	3[a]	4[b]	5[a]	6	7	8	9	10
Demographics										
1. Age	—	-.13	-.05	.06	-.06	-.13	.07	.23	.22	-.16
2. Shipley		—	.21	-.23	.04	.28*	-.13	-.07	.00	-.10
3. Sex[a]			—	-.12	.04	-.24	.14	.12	.20	-.11
4. Race[b]				—	-.05	.13	-.13	-.05	.10	-.01
5. Handedness[a]					—	-.05	.20	-.03	.03	-.22
Individual Differences										
6. YPI Total Score						—	-.21	-.31*	-.18	.26*
Parietooccipital Alpha										
7. Mountain Alpha							—	.20	-.24	-.06
8. City Alpha								—	.13	-.20
Central Alpha										
9. Mountain Alpha									—	-.01
10. City Alpha										—

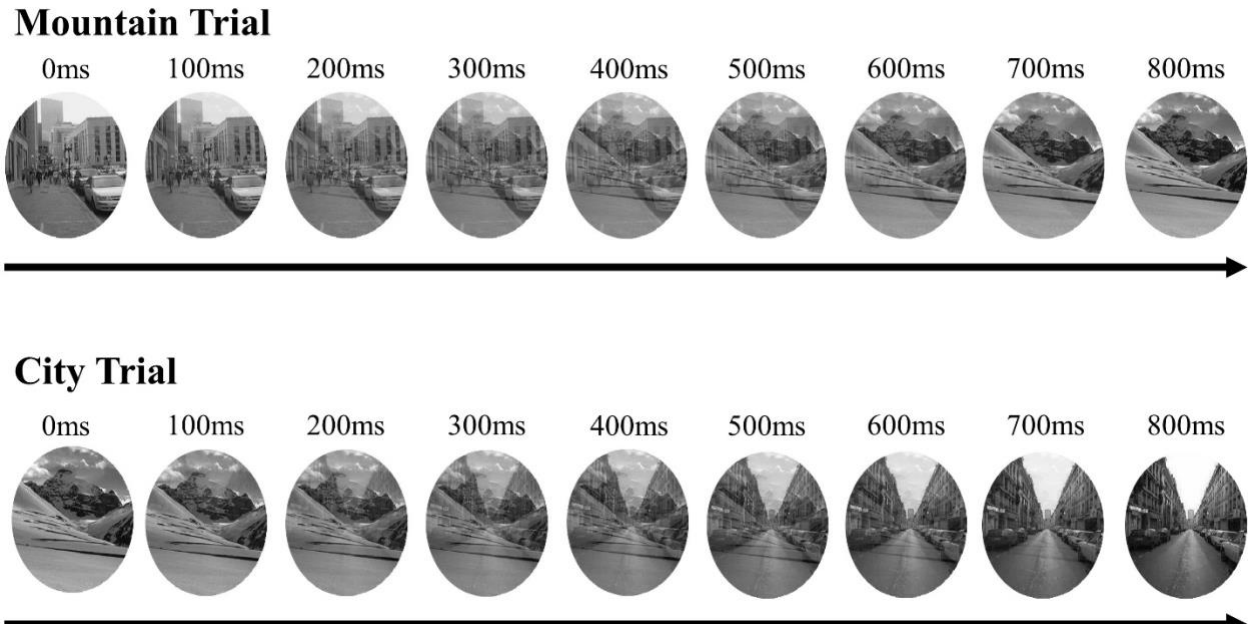
Note. Shipley = Shipley Institute of Living Scale estimated full scale IQ; YPI Total Score = Youth Psychopathy Inventory;

*$p < .05$

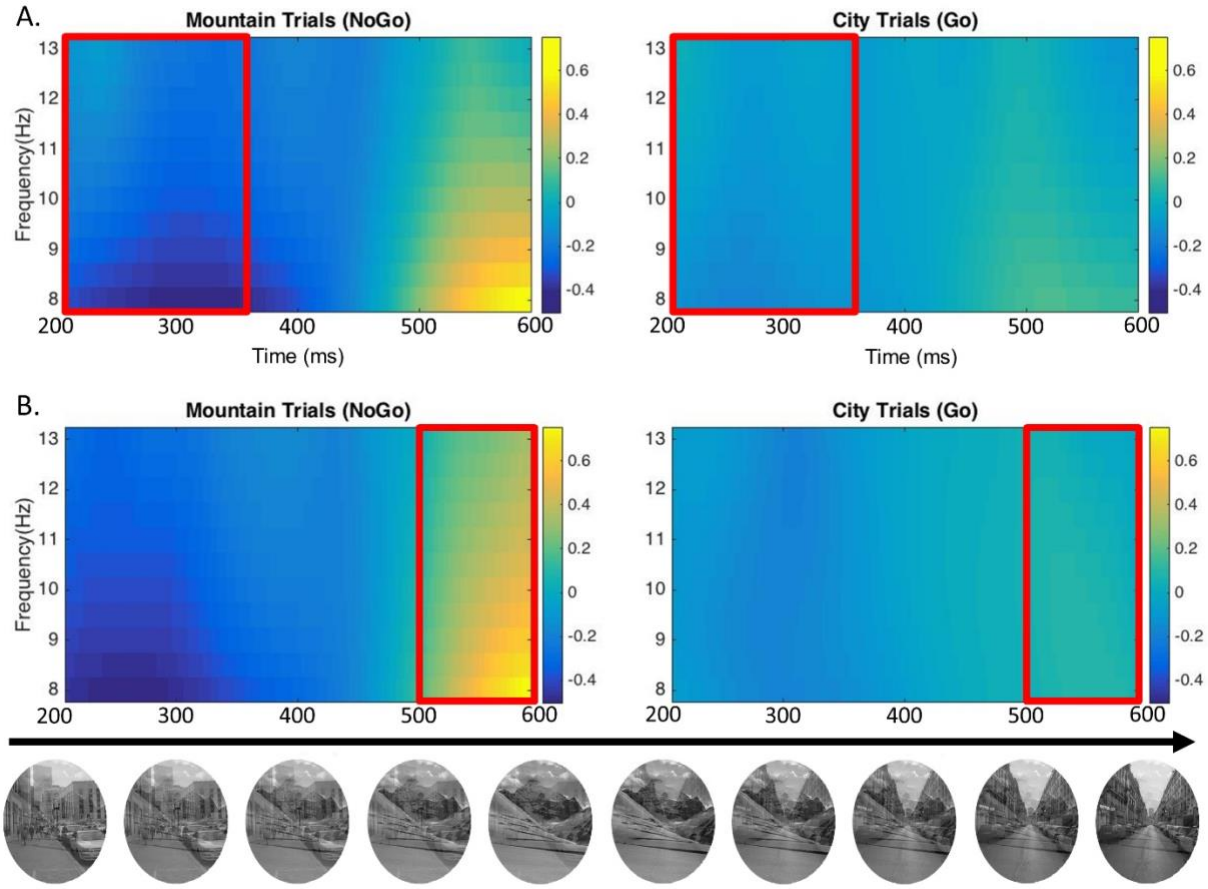
[a]Contrast-coded

[b]Contrast-coded (white vs. other)

Supplemental Figures



Supplemental Figure 1. Task Schematic. Participants were presented with visual scenes which gradually emerged over the 800 ms trial. Participants were instructed to respond (via button press) whenever they saw city scenes (bottom panel), but not to respond when they saw mountain scenes (top panel).



Supplemental Figure 2. Time Frequency Spectrographs. Time-frequency spectrographs show changes in event-related spectral perturbation (ERSP) at parietooccipital head sites following the presentation of Mountain (NoGo) and City (Go) cues (row A), and at central head sites following the presentation of Mountain (NoGo) and City (Go) cues (row B). The red boxes represent time windows which were extracted for analysis. Mean ERSPs were extracted from parietooccipital head sites between 210ms-350ms post-stimulus onset. Mean ERSP were extracted from central head sites between 500ms-590ms post-stimulus onset.