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NEUROCOGNITIVE FUNCTIONING IN BORDERLINE PERSONALITY DISORDER PATIENTS

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ABSTRACT

Past studies have found that executive dysfunction and impulsivity are two main features of Borderline Personality Disorder (BPD; Fertuck et al., 2006). Thus, clinical observations of BPD may be correlated to deficits in neuropsychological processes. This study sought to examine neurocognitive dysfunction in BPD participants compared with healthy controls. Participants were 48 clinically referred individuals reliably diagnosed with BPD and 31 matched healthy controls (HC) recruited from a university participant pool. After the initial diagnostic assessment participants completed the Wisconsin Card Sorting Task (WCST) - a measure of executive function. Independent t-tests and ANCOVA analysis were conducted to examine differences between BPD individuals and HC on the WCST. Those with BPD as compared with HC evidenced significantly greater number of errors, especially perseverative errors, as well as significantly less completed sets and less improvement throughout trials. Those with BPD evidenced a greater number of non-perseverative errors, and more failure to maintain sets –albeit at a trend levels. These findings suggest possible neurocognitive dysfunction in those with BPD. Future research should establish the reliability and specificity of these findings. If replicated, additional research should examine the mechanisms underlying these deficits as well as methods for remediation.

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Chapter 1

Introduction

Borderline personality disorder (BPD) is a chronic and debilitating disorder characterized by emotional instability, difficulty in interpersonal relationships, incoherent self-identity, frequent angry outburst, and impulsivity (Skodol et al., 2002). Both clinical and community epidemiological studies suggests that BPD is more prevalent than better known disorders such as schizophrenia, bipolar disorder, and autism combined (Levy, in press). BPD is also highly comorbid with a number of disorders such as depression, anxiety, PTSD, substance use, and eating disorders. When comorbid, BPD not only affects the course of these disorders but also reduces the efficacy of otherwise effective treatments for these disorders.

The most serious symptom of BPD is the high levels of suicidality and non-suicidal self-injury. Unlike depression where suicidality is often a result of hopelessness, in BPD suicidality and self-injury often result from difficulties with impulsivity and emotion dysregulation – particularly anger and particularly in the context of conflictual interpersonal relationships (Zanarini et al., 2013). A number of theorists have hypothesized that the impulsivity and emotion dysregulation seen in BPD are related to difficulties in underlying neuropsychological processes, such as effortful control seen in executive function (Levy et al., 2010; Fertuck et al., 2006; De Panfilis et al., 2013). However, identifying the underlying neurocognitive difficulties in those with BPD has been elusive. The literature surrounding executive dysfunction in BPD has been inconclusive; some studies have found deficits in BPD individuals whereas others have not (Ruocco, 2005). The present study has the potential to clarify gaps in the literature and contribute to our understanding of neurological deficits of BPD.

The Wisconsin Card Sorting Task is a computerized task known to measure executive function (WCST; Heaton, 1981). Specifically, it measures concept formation, cognitive flexibility, and the ability to shift attention and thinking when necessary (Lenzenweger et al, 2004). Many studies have utilized the Wisconsin Card Sorting Task to understand deficits in neurocognition and executive function. Studies utilizing the WCST in traumatic brain injury patients have seen correlations in physical brain damage and deficits of the Wisconsin Card Sorting Task. Findings demonstrate that individuals with frontal lobe damage perform worse on the WCST than do healthy controls (Demakis, 2003). Other studies have found that individuals with disorders known to correlate with neurological processes, such as schizophrenia and autism spectrum disorder, also perform poorly on the Wisconsin Card Sorting Task. Thus, the WCST is highly related to the physical neurological processes occurring in the brain. Individuals who perform poorly on the Wisconsin Card Sort Task are thought to have difficulty using information from the environment to change or regulate behavior. Thus, observed clinical symptoms of BPD, in which a client has difficulty with affect regulation and behavior regulation, could translate to deficits in neurobiological processes that are responsible for concept formation, cognitive flexibility, and ability to shift attention.

Many studies have attempted to explore the relationship between BPD and the neurological processes underpinning the clinical symptoms via the WCST. However, studies have differed in their findings. For instance, although O'Leary et al (1991) provided evidence for neurological differences in BPD individuals and healthy controls, Biskin et al (2011) found that there were no differences in BPD females on the WCST. However, Biskin et al had participants whose mean ages were 19.1 for BPD individuals and 20.3 for healthy controls. Such young ages may mean that errors on the WCST were not due to deficits of executive function but rather, age. Other studies have identified differences in BPD individuals to Traumatic Brain Injury victims in which BPD individuals performed better than those with frontal lobe damage; however this does

not provide evidence of whether BPD individuals have deficits in comparison to healthy controls (Lenzenweger et al., 2004; Reekum, 1996). Further examination of various studies reveals that although total error and perseverative error differ among studies, the majority of studies reveal that healthy controls complete all categories while BPD individuals across studies fail to complete all six sets (Lenzenweger, 2004; Swirsky-sacchetti, 1993; O'Leary et al, 1991). Additionally, a meta-analysis of various studies reveals that BPD and healthy comparison groups have significant differences across multiple domains of neuropschological test (Ruocco, 2005).

The present study sought to clarify these inconsistent findings with regard to understanding of neurocognition of BPD. Many studies have compared BPD neurocognitive performance to unhealthy controls or those of a limited age range. In the present study we compare BPD individuals to both healthy controls and those who have been temperamentally matched to the BPD patients based on impulsivity and negative affect. Thus, our study screens healthy controls who also endorse temperamental aspects of Borderline Personality Disorder. Comparing BPD individuals to both temperamentally matched and unmatched healthy controls may provide further insight into the spectrum of neurocogntivie deficits that may be found in BPD individuals. Although a conservative approach, by comparing BPD individuals to matched and unmatched healthy controls, as oppose to healthy controls, we can better determine if the neurocognitive deficits are related to broad temperamental traits or to the disorder itself (Kagan, 1994, 2008; Rothbart et al., 1994). This approach has been successfully applied with BPD patients in a number of studies (Posner et al., 2003; Scott et al., 2013).

We hypothesize that the BPD group will significantly differ from matched and unmatched healthy controls, indicating that individuals who meet criteria for BPD demonstrate executive dysfunction as oppose to those who are sub-threshold or do not endorse BPD symptoms. Demographics information for these individuals will also be collected to eliminate personal dimensions outside of mental health diagnosis (i.e. social economic status, education

level, age) that may affect executive function.

Chapter 2

Methods

Participants

Participants were 48 clinically referred individuals from two outpatient clinics, one in New York City and the other in Pennsylvania, who met DSM-IV criteria for Borderline Personality Disorder. Clinically referred individuals were administered the Structured Clinical Interview for DSM-IV (SCID-I; First et al., 2002) and the International Personality Disorder Examination (IPDE; Loranger, 1999) by trained graduate students to ensure that a clinical diagnosis of BPD. Thirty-one healthy controls were volunteers recruited from university participant subject pools in New York and Pennsylvania. Healthy controls were also administered the SCID-I and the IPDE by trained graduate students to ensure that healthy controls did not have a personality disorder diagnosis. However, healthy controls were screened for endorsing borderline personality disorder traits without a diagnosis. For all participants, graduate students administering the interviews were blind to the participant's condition. LEAD meetings were conducted if necessary. Individuals were assessed for general psychological difficulties. Healthy controls with high impulsivity and negative affect were considered temperamentally matched healthy controls while individuals who did not endorse BPD temperaments were considered non-temperamentally matched healthy controls. All participants were females. Participant's ages ranged from 20-45. Participants were excluded if they were younger than 20 or older than 45 based on the concept that age is highly correlated with executive function; older individuals tend to do worse on the Wisconsin Card Sort Task due to age related mechanisms (Fristoe et al, 1997; Rhodes, 2004). The mean age of the clinical sample was 30.96 (SD= 6.87) and the mean age of

the healthy controls was 26.58 (SD= 8.19). Within the clinical sample, 12.5% identified as black or African American, 72.9% identified as Caucasian, 4.2% identified as Asian and 10.4% identified herself as other. Within the control sample, 16.1% identified as black or African American, 67.7% identified as Caucasian, 3.2% identified as Hispanic, and 6.5% identified as other. Participants in both the clinical and control samples tended to have some college or to have graduated college (see table 1).

Measures

The SCID-I, IPDE, and AAI were all used as interviews. The Structured Clinical Interview for the DSM-IV (SCID-I) is a diagnostic exam used to determine both Axis I and Axis II disorders. The assessment includes questions about psychiatric history and past and current symptoms (First et al., 2002). The International Personality Disorder Examination (IPDE) is a semi structured clinical interview used to asses personality disorders and is compatible with the International Classification of Diseases (Loranger, 1994). The Adult Attachment Interview (AAI; George, Kaplan, & Main, 1985) is used to evaluate childhood experiences and how those experiences may have affected adult personality. All three of these interviews assist in determining appropriate BPD diagnosis as well as evaluating other psychological difficulties.

The participants were administered a demographics questionnaire that asked questions on race and ethnicity, income level, education level, parent's education level, and family dynamics (married, single, divorced; have children, do not have children).

The participants were administered two neurocognitive tasks: the Wisconsin Card Sorting Task and the Continuous Performance Task. The Continuous Performance Task (CPT) is a neuropsychological test which measures attention and impulsivity.

The Wisconsin Card Sort Task (WCST; Heaton, 1981) is a neurocognitive task known to measure the executive functions of concept formation and set shifting. The WCST can be administered to participants by hand or on a computer. In the present study computer administration was employed. Four cards are displayed, each with a different shape (triangle, star, crosses, or circles), color (red, green, yellow, or blue), and number of shapes (1, 2, 3, or 4). These cards are arranged so that left to right the cards are one red triangle, two green stars, three yellow crosses, and four blue circles. The participant is then given one additional stimulus card and told to match the card to one of the four cards mentioned above; however the participant is not told how to match the cards. Thus, the participant can chose to match based on shape, color, or number. After matching the card, the participant will receive feedback that the match is either right or wrong (see figure 1-3). The participant must change their matching style for the next card in order to get the next match right. After a few rounds of matching, the matching rules will change and the participant will have to adjust how they match their cards to match the new matching rule. The task has a total of six categories or sets which are six different rules that it will run through. Participants who complete all sets or categories are able to grasp the matching rule of each category. However, participants who do not complete all sets are not able to understand the rule sets for each category. Perseverative errors are when the participant matches a card to the wrong rule set and is told that they are wrong but continues to match the card to the same rule set in the next round. Non-perseverative errors are when the participant makes an incorrect response that is of some other rule. Conceptual level responses are measured when the participant has three or more consecutive responses. After the game is done, the WCST program provides information on the performance of the participant throughout the task.

Through errors and response types, the WCST is able to measure the ability of a participant to switch rule sets and to accurately use feedback given from the environment. This

translates into specifically measuring ability for concept formation, cognitive flexibility, and the ability to shift attention and thinking when necessary.

Procedures

All measures and procedures in the study were approved by the institutional review board and all participants were provided informed consent before partaking in the study. Clinical participants were recruited from the Penn State Psychology Clinic via staff therapists, posted flyers within the clinic waiting room, and phone calls to participants from previous studies (Scott et al., 2013; Beeney et al., 2013; Scott et al., 2011). Healthy controls were recruited via Penn State's and Hunter College's respective Subject Pools and were all enrolled in Introduction to Psychology classes. Participants were run in two independent sessions. Recruited clinical participants arrived individually to our lab space where they met with trained graduate students and were administered three interviews—the AAI, the SCID-I, and the IPDE. Healthy Controls also arrived individually to our lab space and were interviewed using the AAI, SCID-I, and IPDE in order to exclude personality disorder diagnosis. Both healthy controls and BPD individuals were given a demographics questionnaire and self-report measures. The entire first part of the study took approximately 1 to 2 hours.

Individuals were asked to return to the lab for a separate session. Individuals were administered computerized tasks and a number of self-report measures not relevant for this manuscript. Some of the self-report measures varied between sites depending on whether the assessment was at Cornell, Hunter College or PSU. All participants received the Computerized tasks which included the Wisconsin Card Sorting Task (WCST) and the Continuous Performance Task (CPT). The lab session took approximately 60 minutes. The main focus of this manuscript is the results of the Wisconsin Card Sort Task.

Data-Analysis

Independent sample T-tests were used to compare results of BPD participants, temperamentally matched controls, and Non-temperamentally matched controls. Temperamentally matched and non-temperamentally matched controls did not statistically differ, thus matched and unmatched controls were placed under one group as healthy controls (see table 3). An independent sample T-test was conducted to compare differences between BPD individuals and healthy controls. Although the variance in age between clinical and control was not statistically significant, a bi-correlate revealed that some measures correlated to age, therefore ANCOVA analyses was conducted to account for any age confounds (see table 2).

Chapter 3

Results

The hypotheses were generally supported. ANCOVA results controlling for age revealed there were significant differences between the BPD population and the healthy controls with respect to neurocognition. The BPD population had significantly higher percentage of errors on the WCST than the healthy controls (BPD M=26.46 (SD=22.55); HC M=16.58 (SD=11.23)). Specifically, BPD individuals had more perseverative errors (BPD M=12.58 (SD=6.43); HC M=3.45 (SD=4.59)) demonstrating cognitive inflexibility. BPD individuals also had significantly less conceptual level responses (BPD M=61.27 (SD=14.70); HC M=64.87 (SD=4.65)) meaning BPD individuals were less likely to get three or more consecutive responses correct than the controls. BPD individuals has had less number of completed sets (BPD M=5.23 (SD=1.74); HC M=6.00 (SD=0.00)) while healthy controls completed all sets with no deviation. Less conceptual responses and inability to complete all sets demonstrates that BPD individuals had difficulty with concept formation. BPD individuals also had significantly less improvement throughout trials (BPD M= -0.32 (SD=4.04); HC M=1.31 (SD=3.66)) indicating less ability to change behaviors due to environmental cues.

Number of sets failed to maintain is a measure of shift setting abilities. This occurs when a participant changes from providing correct responses to an incorrect response despite feedback that their original response was correct (Levy et al, 2005). Number of sets failed to maintain was at a trend level in the predicted direction (BPD M=0.62 (SD=0.97); HC M=0.16 (SD=0.58)). Percent of non-perseverative errors was at a trend level in the predicted direction

as well (BPD M=12.38, (SD=10.51); HC M=8.71 (SD=4.64)), indicating that BPD individuals had more errors regardless of perseveration.

In general, the ANCOVA revealed statistical significance for total number of trails [F (1, 78)=4.64, *p=0.034*], percent of total errors [F (1, 78)=4.78, *p=0.032*], percent of perseverative error [F (1,78)=4.61, *p=0.035*], percent of conceptual level responses [F (1,78)=6.07, *p=0.016*], number of completed sets [F (1,78)=6.57, *p=0.012*], and improvement throughout trail [F (1,78)=4.45, *p=0.039*]. Percent of non-perseverative error [F (1, 78) =3.75, *p=0.056*] and number of sets failed to maintain [F (1, 78) =3.13, *p=0.081*] were not significant but were trends in the predicted direction. Number of trials to complete first set was not significant [F (1, 78) =2.02, *p=0.159*].

A bi-correlate was conducted to examine the relationship between demographics and the Wisconsin Card Sort task. Ethnicity and race did not correlate to any outcomes on the WCST. Current employment status, education level, and annual income level did not correlate to the WCST. For clinical participants, both having children and parent's education level, specifically father's education level, correlated to a few outcomes of the WCST. For control participants, no demographics factors correlated to WCST outcomes. An ANCOVA analysis was conducted to account for father's education level. An ANCOVA analysis revealed that father's education level significantly accounted for many of the outcomes on the WCST (see table 4). In addition, whether a participant had a child or not accounted for many of the outcomes on the WCST (see table 5). These findings should be further examined to understand how parental education level and child bearing plays a role in executive function of Borderline Personality Disorder.

Chapter 4

Discussion

The primary goal in this study was to evaluate neurocognitive dysfunctions within the BPD population compared to healthy controls utilizing the Wisconsin Card Sorting Task. Clinical observations of impulsivity, interpersonal difficulties, and tendencies of self-harm are predicted to correlate with deficits in executive dysfunction; specifically deficiencies in planning, abstract thinking, flexibility, and control. The Wisconsin Card Sorting Task is known to measure different facets of executive function. Thus, administering the WCST to individuals with a confirmed BPD diagnosis could allow us to understand various deficits of executive function within the borderline personality disorder population. However, previous research surrounding neurocognitive deficits of BPD have been inconclusive (Ruocco, 2005). Thus, our study sought to provide additional information on executive dysfunction of borderline personality disorder by comparing individuals with confirmed diagnosis to temperamentally matched and non-temperamentally matched healthy controls.

Results from the current study provide additional support for the hypothesis that the clinical observations of BPD correlate to underlying neurological deficits, specifically deficits in executive functioning. The temperamentally matched and unmatched healthy controls did not statistically differ from one another in any category, thus there is no evidence that analogues of borderline personality disorder show deficits in executive dysfunction. When comparing BPD participants to our combined group of both temperamentally- and non-temperamentally-matched healthy controls, we found a number of significant differences between controls and the BPD group as well as some important trends in the predicted direction. Our findings suggest that there

are clear cognitive deficits between BPD participants and healthy controls. Meeting criteria for BPD correlates with specific neurocogonitive deficits. BPD individuals displayed cognitive inflexibility, difficulty in concept formation, and the inability to shift attention and thinking when necessary. Additionally, there was a surprising finding that performance on the WCST correlated to both father's education level and child bearing. This coincides with the idea that there is an environmental and social element contributing to Borderline Personality Disorder. Further examination of family dynamics should be examined in relation to neuropsychological deficits.

Several theories have discussed Borderline Personality Disorder as an intersection of both biological and environmental factors. Kernberg (2005) discusses how personality disorders are derived from both constitutional and environmental factors in early life. More specially, temperament, which is defined as particular reactions to environmental cues at various thresholds, and aspects of cognition are innate qualities. Thus, these genetically determined factors play a role in personality disorders. Additionally, work by Fonagy examines BPD as having both a neurobiological and psychosocial basis. Fonagy discusses the importance of biological vulnerabilities as well as attachment relationships with caregivers at an early age in the development of borderline personality disorder, emphasizing that attachment relationships in early life can play a role in emotion regulation throughout a lifespan (Fonagy et al, 2003). Another theory of the development of BPD is the biosocial theory developed by Linehan (1993). This theory focuses on BPD as a heterogeneous phenotype in which biological vulnerabilities and environmental risk lead to diagnosis (Crowell et al, 2009).

Our research is consistent with various theories that acknowledge Borderline Personality Disorder as having biological components. Understanding the neurocognitive deficits of Borderline Personality Disorder can enhance the understanding of the constitutional domains of borderline personality disorder. Environmental and social influences on BPD seem to be vital as well; our results demonstrate that family dynamics plays a role in the outcome of neurocognition.

Our research has the potential to enhance the information we have on neurocognition in borderline personality disorder. In addition to the published literature surrounding executive dysfunction in BPD, our research contributes to our understanding of neurocognitive deficits. Specifically, our research reveals that individuals diagnosed with BPD have trouble with shifting task, conceptual formation, completing sets, and improving throughout the task. In addition, our results are consistent with the idea that BPD individuals persistently fail to complete sets while healthy controls consistently complete all sets with no deviation. Our study also has peculiar findings in relation to family dynamics and neurocongition that contribute to our understanding of social and environmental components of BPD. This study can be replicated by others utilizing various comparison groups to examine neurocognitive deficits of BPD.

Clinical observations of borderline personality disorder have provoked researchers to examine executive function of personality disorder. Underlying neurocognitive deficits within the borderline personality disorder population could explain impulsivity and difficulty with control and planning, difficulty with changes in the environment, difficulty in interpersonal relationships, and persistent self-harm. Utilizing information on neurocognitive deficits within borderline personality disorder could help psychologist to better formulate psychotherapy techniques directed at alleviating symptoms of borderline personality disorder. Our results demonstrate that individuals with BPD have significantly greater preservative error, illustrating that individuals with BPD have particular difficulty with shifting thinking when necessary. This is consistent with the clinical observation that BPD individuals can have inflexible rational and difficulty switching mindsets. The inflexible thinking that occurs in BPD individuals is consistent with Kernberg's object relations theory that describes BPD individual's inability to integrate one's identity (Kernberg, 1984). Kernberg hypothesizes that BPD individuals may be motivated to keep representations of themself or others separate to protect themselves (Levy et al, 2006). BPD individuals typically engage in splitting where the individual holds one idea about an object while

suppressing other ideas about the same object. For example, a BPD individual may think of their mother as very cruel, while suppressing the feelings that their mother may also be nurturing and endearing at times. Hence, this individual is engaging in inflexible thinking, or perseveration, because she is not able to hold multiple, or integrated, representations of an individual at one time. Based on our results demonstrating increased preservative error in BPD and Kernberg's theory, therapist patient dyads that focus on flexible thinking by increasing reflection, affect regulation, and identity integration has the potential to improve symptoms of BPD. These are core principles in Transference Focused Psychotherapy (TFP). TFP examines identity diffusion in BPD patients and seeks to created integrative concepts of oneself (Hopwood et al, 2014). By achieving identity integration in TFP, BPD individuals can stop perseverating, and change thinking when necessary. Furthermore, our results were significantly affected by family dynamics. This emphasizes the common practice in psychotherapies to examine interpersonal relationships and family dynamics as part of BPD treatment. As one example, TFP works with BPD individuals to create more integrative representations of significant others to improve interpersonal relationships.

Limitations of this study include age differences between our BPD group and HC group. Our BPD group had a higher mean age as oppose to our healthy controls. Although we controlled for this difference statistically, age has been known to correlate with executive dysfunction and thus different age cohorts could be a confound within this study. However, this age difference runs opposite our findings as research has consistently found that younger populations tend to be more impulsive. A second limitation was the use of a non-clinical control group. Utilizing a clinical control group could allow us to evaluate how much of the deficits on the WCST are specific to BPD rather than a general psychological deficit. Moreover, demographics information on parental education and child bearing had a significant role in our outcomes. Although this is an interesting finding that may have important implications for understanding our results.

Additionally, the results for the WCST should be compared directly to other measures, especially neurocognitive tasks.

Future research should explore the mechanisms for neurocognitive deficiencies in the borderline population. Further examination is necessary to understand the differences in BPD analogues and BPD diagnosis. In addition, further research is necessary to understand if differences found in BPD participants and healthy controls are due to biological genome differences, childhood experiences, or an interaction between the two. Our demographics reveal that SES and education are not predictors of executive dysfunction, however other facets of life events should be considered, such as childhood trauma or parents psychopathology.

Appendix

Tables and Figures

Table 1. Demographics

Characteristics	BPD (n=48)		Control (n=31)	
	N	%	N	%
Gender				
Female	48	100	31	100
Male	0	0	0	0
Race				
Asian	2	4.2	2	6.5
Black/ African American	6	12.5	5	16.1
Hispanic	0	0	1	3.2
White	35	72.9	21	67.7
Other	5	10.4	2	6.5
Education				
High School Graduate or Equivalent	9	18.8	5	16.1
Partial College	13	27.1	12	38.7
Associate Degree	1	2.1	1	3.2
Standard College	17	35.4	6	19.4
Masters Level	6	12.5	3	9.7
Doctoral Level	1	2.1	0	0
Not reported	1	2.1	4	12.9
Marital Status				
Single	34	70.8	23	74.2
Married	7	14.6	4	12.9
Separated/divorced	7	14.6	1	3.2
Not reported	0	0	3	9.7
Current Employment				
Employed full-time	10	20.8	5	16.1
Employed part-time	12	25.0	12	38.7
Unemployed	26	54.2	11	35.5
Not Reported	0	0	3	9.7
	Mean	SD	Mean	SD
Age (years)	30.96	6.87	26.58	8.19

Table 2. ANCOVA accounting for age of BPD and controls on WCST

WCST	BPD (n=48)	Control (n=31)	F value	P-value
	M (SD)	M (SD)		
Total number of trials	94.75 (22.29)	84.55 (15.46)	4.64	0.03
Percent of total errors	26.46 (22.55)	16.58 (11.23)	4.78	0.03
Percent of perseverative errors	12.58 (6.43)	3.45 (4.59)	4.61	0.04
Percent of non-perseverative errors	12.38 (10.51)	8.71 (4.64)	3.75	0.06
Percent of conceptual level responses	61.27 (14.708)	64.87 (4.65)	6.07	0.02
Number of completed sets	5.23 (1.74)	6.00 (.00)	6.57	0.01
Number of trials to complete first set	24.96 (31.97)	16.29 (11.67)	2.02	0.16
Number of sets failed to maintain	0.62 (.97)	0.16 (.58)	3.13	0.08
Improvement throughout trials	-0.32 (4.04)	1.31 (3.66)	4.45	0.04

Table 3. Independent Sample T Test temperamentally matched v non-temperamentally matched

WCST	Matched HC (n=16)	Non-matched HC (n=15)	t value	P-value
	M (SD)	M (SD)		
Total number of trials	82.56 (12.89)	86.67 (18.01)	-0.73	0.46
Percent of total errors	17.06 (6.05)	19.60 (9.94)	-0.85	0.40
Percent of perseverative errors	9.44 (4.13)	11.07 (7.38)	-.076	0.45
Percent of non-perseverative errors	7.25 (5.21)	9.00 (7.13)	-0.78	0.43
Percent of conceptual level responses	65.31 (6.22)	64.40 (2.06)	0.54	0.59
Number of completed sets	6.00 (0.00)	6.00 (0.00)	---	---
Number of trials to complete first set	16.31 (12.10)	16.27 (11.62)	.011	0.99
Number of sets failed to maintain	.31 (.793)	0.00 (0.00)	1.57	0.13
Improvement throughout trials	1.97 (3.53)	0.62 (3.79)	1.03	0.31

Table 4. ANCOVA accounting for Father's Education Level

WCST	BPD (n=48)	Control (n=31)	F value	P-value
	M (SD)	M (SD)		
Total number of trials	94.75 (22.29)	84.55 (15.46)	2.75	0.10
Percent of total errors	26.46 (22.55)	16.58 (11.23)	2.257	0.14
Percent of perseverative errors	12.58 (6.43)	3.45 (4.59)	2.43	0.12
Percent of non-perseverative errors	12.38 (10.51)	8.71 (4.64)	1.32	0.21
Percent of conceptual level responses	61.27 (14.708)	64.87 (4.65)	2.68	0.11
Number of completed sets	5.23 (1.74)	6.00 (.00)	2.76	0.10
Number of trials to complete first set	24.96 (31.97)	16.29 (11.67)	.499	0.48
Number of sets failed to maintain	0.62 (.97)	0.16 (.58)	5.02	0.03
Improvement throughout trials	-0.32 (4.04)	1.31 (3.66)	2.27	0.14

Table 5. ANCOVA accounting for children

WCST	BPD (n=48)	Control (n=31)	F value	P-value
	M (SD)	M (SD)		
Total number of trials	94.75 (22.29)	84.55 (15.46)	2.77	0.10
Percent of total errors	26.46 (22.55)	16.58 (11.23)	3.20	0.07
Percent of perseverative errors	12.58 (6.43)	3.45 (4.59)	2.910	0.09
Percent of non-perseverative errors	12.38 (10.51)	8.71 (4.64)	2.46	0.12
Percent of conceptual level responses	61.27 (14.708)	64.87 (4.65)	3.76	0.06
Number of completed sets	5.23 (1.74)	6.00 (.00)	4.39	0.04
Number of trials to complete first set	24.96 (31.97)	16.29 (11.67)	1.33	0.25
Number of sets failed to maintain	0.62 (.97)	0.16 (.58)	3.618	0.06
Improvement throughout trials	-0.32 (4.04)	1.31 (3.66)	2.80	0.09

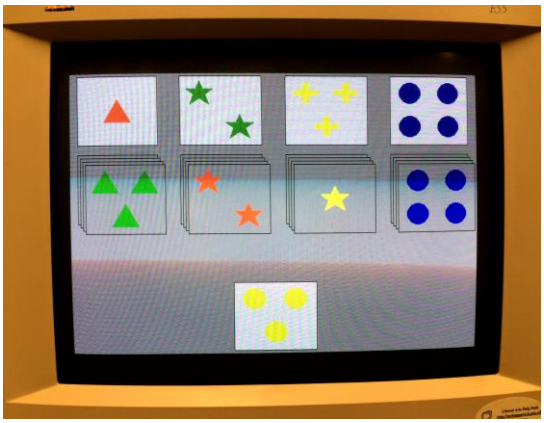

Figure 1. Wisconsin Card Sorting Task

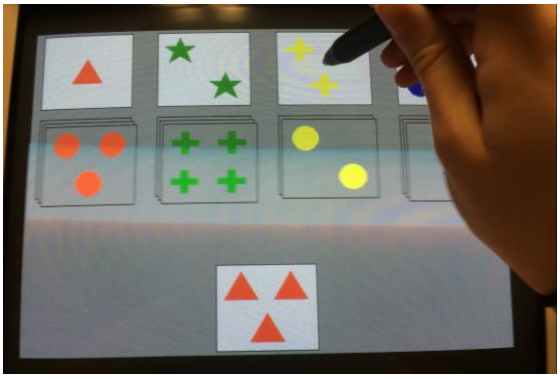

Figure 2. WCST- Participants used a light pen to select choice

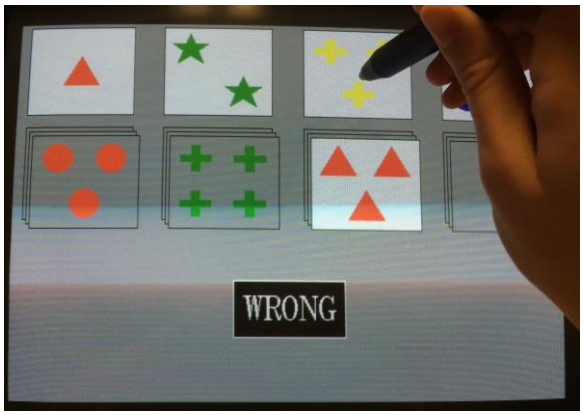

Figure 3. WCST- Participants received feedback with the words "Right" or "Wrong"

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Education

2010-2014 The Pennsylvania State University, University Park, PA
B.S. in Psychology, Biological and Evolutionary Sciences Focus
Minors in English & Sociology
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Honors and Awards

2014 Joseph R. Goldstein Honors Scholarship
2013 College of the Liberal Arts Enrichment Fund
2013 Psychology Department Funding Award
2013 Donald A. Trumbo Psychology Department Student Research Fund
2011-2013 Pennsylvania State University Dean's List
2010 Outstanding Community Service Award

Research Experience

May 2013-Present *Trier Social Stress Test Coordinator,* Personality, Psychopathology, and Psychotherapy Laboratory, Penn State University; PI: Kenneth N. Levy, Ph.D.

Responsibilities as the Trier Social Stress Test Coordinator include consenting and running participants through the Trier Test, collecting cortisol samples, and various psychophysiological measures. Responsibilities also include coordinating resource availability, research assistant availability, as well as coordinating across research labs to run participants in various studies.

August 2012- May 2013 *Participant Recruitment Co-coordinator,* Personality, Psychopathology, and Psychotherapy Laboratory, Penn State University; PI: Kenneth N. Levy, Ph.D.

Responsibilities as a Participant Recruitment Co-coordinator include calling clinical and university subject populations for participation recruitment, scheduling individuals to run in various studies, placing reminder calls, creating participant records in Access database, and ensuring participant payment.

May 2012- Present *Research Assistant, Personality*, Psychopathology, and Psychotherapy Laboratory, Penn State University; PI: Kenneth N. Levy, Ph.D.

Various responsibilities including entering participant data into Excel and SPSS, finding and scanning journal articles into EndNote and Mendeley, compiling and editing citations, transcribing Adult Attachment Interviews, as well as consenting and running participants in various studies using E Prime, Inquisit, Acqknowledge, and Biopac software.

Feb 2013- Aug 2013 *Research Assistant,* Behavioral Neuroendocrinology Lab
Bio-behavioral Health Department, Pennsylvania State University; PI: Sonia Cavigelli, Ph.D.

Responsibilities include working with rodents in a research setting including rodent breeding, rodent experiments, rodent behavioral testing, necropsies, and PCR techniques to examine RNA and DNA markers of behavior. Rodent experimentation includes collecting blood samples, utilizing whole body plethysmographs, and female rodent smearing. Rodent behavioral testing includes elevated plus maze, forced swim test, open field test, light dark box test, and sucrose preference test.

Summer 2009 *Research Assistant,* American Red Cross Summer Program
Walter Reed Army Medical Center, Department of Vascular Surgery and Radiology; PI: Irwin Feuerstein, M.D.

Responsibilities included working on two projects; creating a teaching and research database comparing CT, MR and catheter arteriography images in Microsoft Access, and creating an interdisciplinary brochure for a combined Vascular Surgery-Radiology clinical service.

Work Experience

May 2012-Present *Direct Support Specialist,* Community Services Group, State College, PA

Community Residential Rehabilitation setting for adults with mental health disorders
Responsibilities include helping individuals regain independence within the community via emotion regulation, money management, self-directed care, and encouraging community participation. Responsibilities also include becoming a first responder in crisis situations.

May 2012- May 2013 *Direct Support Professional*, Strawberry Fields Inc., State College, PA

Residential setting for adults with intellect disabilities
Responsibilities include helping individuals with daily living skills, personal care and medical administration, encouraging community integration and communication skills, and emotion regulation.

Publications and Presentations

Dua, A., Fox, J., Patel, B., Martin, E., Rosner, M., Fox, C. (2013). A Team Approach to Anterior Lumbar Spine Surgery in the Military. Vascular.

Fox, J. L., & Levy, K. N. (2013, April). Neurocognitive functioning in borderline personality disorder patients. Poster presented at the Annual Conference of the North American Society for the Study of Personality Disorders, Boston, MA.

Fox, J. L., & Levy, K. N. (2013, April). Neurocognitive functioning in borderline personality disorder patients. Poster presented at the Pennsylvania State University Annual Undergraduate Exhibition, University Park, PA.

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