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The Tryptophan Hydroxylase-1 A218C polymorphism is associated with diagnosis, but not suicidal behavior, in borderline personality disorder

Scott T. Wilson, Ph.D.^{1,2}, Barbara Stanley, Ph.D.^{1,2,3}, David A. Brent, M.D.⁴, Maria A. Oquendo, MD.^{1,2}, Yung-yu Huang, MS.^{1,2}, and J. John Mann, M.D.^{1,2}

¹Division of Molecular Imaging and Neuropathology, New York State Psychiatric Institute

²Department of Psychiatry, Columbia University College of Physicians & Surgeons

³Department of Psychology, City University of New York-John Jay College

⁴Department of Psychiatry, University of Pittsburgh Medical Center

Abstract

While there is some preliminary evidence that the Tryptophan Hydroxylase I (TPH1) polymorphisms are related to Borderline Personality Disorder (BPD), it is not clear if this association is due to the high rates of suicidal behavior in this patient group. Because of the reported association between TPH1 polymorphisms and suicidal behavior, determining whether TPH1 is related to BPD independent of suicidal behavior is of particular importance. One hundred patients diagnosed with BPD and 101 healthy controls were genotyped for TPH1 Intron 7 A218C polymorphism and assessed for impulsiveness and hostility. The BPD patient group had a higher frequency of A allele carriers (AA/AC genotypes) than the control group ($\chi^2=6.12$, $df=1$, $p=.01$), and differed by genotype frequencies ($p=.03$). Suicide attempter status in the patient group was not related to genotype. Logistic regression analysis controlling for age and gender predicted BPD diagnosis from TPH1 allele group (AA/AC vs. CC, $p = .03$), and TPH1 heterozygotes (AC) appeared to have the highest risk for BPD ($p=.03$). In the full sample, participants with the AC genotype had higher impulsiveness and hostility scores. However, TPH1 did not predict these traits in either of the groups independently, suggesting the association may be an artifact of the association between TPH1 and BPD. Results suggest that the A allele of the Tryptophan Hydroxylase 1 A218 polymorphism may be associated with BPD, and that it does not appear to be related to suicidal behavior in this population. An aspect of BPD pathology may be due to serotonergic dysfunction.

Keywords

TPH1; tryptophan hydroxylase; A218C; Borderline Personality Disorder; Suicide; Impulsivity; Impulsiveness

Address correspondence to: Scott T. Wilson, Ph.D. Columbia University Department of Psychiatry 1051 Riverside Drive, Unit 42 New York, New York 10032 stw16@columbia.edu Phone: 212 543-6236 Fax: 212 543-6946.

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Introduction

Borderline Personality Disorder (BPD) is a serious, disabling condition with significant morbidity and mortality. Individuals with this disorder have high rates of both nonsuicidal self-injurious behavior (Zisook et al., 1994) and suicide attempts (Black et al., 2004), and a completed suicide rate of approximately 10% (McGlashan, 1986). Although Borderline Personality Disorder is sometimes confused with or classified as a cyclical mood disorder (e.g., bipolar I and II disorders), research suggests that it is a distinct disorder with a unique set of characteristic symptoms and traits (Henry et al., 2001; Stanley & Wilson, 2006; Wilson et al., 2008), with a distinct illness course (McGlashan et al., 2006; Zanarini et al., 2007) and specialized treatment approaches (Oldham, 2005). Although little is known about the etiology of the disorder, recent research has demonstrated that there is a large heritable component in BPD (Torgersen, 2000). As evidence suggests it may be the traits associated with the disorder, rather than the disorder itself, that may be heritable (Torgersen, 1984; Coccaro et al., 1993), genetic research with BPD should also consider BPD component traits. Patients with BPD are often characterized by high levels of impulsivity and aggression (McGlashan et al., 2005), both of which have been linked to serotonergic dysfunction (Carver and Miller, 2006). Thus, genes related to the serotonin system are potential candidate genes.

Of the several serotonin-related genes studied so far in relation to BPD, one of the most promising genes is the tryptophan hydroxylase I gene (TPH1). Tryptophan hydroxylase is the rate-limiting enzyme in the serotonin metabolic pathway, and is responsible for catalyzing the conversion of tryptophan to 5-hydroxytryptophan. Although TPH1 mRNA has been isolated in the CNS in low levels in adulthood (Zill et al., 2007), it is primarily expressed in tissues outside the brain in adults (Sakowski et al., 2006). Of several different polymorphisms have been studied, most research with TPH1 has involved two single nucleotide polymorphisms (SNP) located in intron 7, designated as A218C (rs1800532) and A779C (rs1799913). These polymorphisms are in high linkage disequilibrium in several populations (Nielsen et al., 1997), and have been studied somewhat interchangeably.

While there is some preliminary evidence that TPH1 is related to either BPD or the traits associated with the disorder, the one study showing an association between the disorder and the gene (Zaboli et al., 2006) has limited generalizability because it included only female BPD patients with a history of suicidal behavior. Because of the reported association between TPH1 polymorphisms and suicidal behavior (Bellivier et al., 2004), determining whether TPH1 is related to BPD independent of suicidal behavior is of particular importance. The aim of this research was to study the relationship between TPH1 A218C genotype and BPD diagnosis including both suicide attempters and nonattempters, in an effort to determine whether TPH1 was related to BPD independent of suicidal behavior. In addition, we also examined the relationship between genotype and several traits typically associated with BPD. We hypothesized that the percentage of A allele carriers (AA/AC) would be greater in the BPD group, and that the A allele carriers would show elevated levels of hostility and impulsiveness across groups.

Method

Participants

A total of 201 participants were selected from a larger sample admitted to a multisite project on mood disorders and suicidal behavior. One hundred patients diagnosed with BPD and 101 non-psychiatric controls were included in the analyses. All but one of the members of the patient group was diagnosed with either major depressive disorder (73) or a bipolar disorder (26). The remaining member of the patient group (1 out of 100) was diagnosed with

an anxiety disorder only. Seventy-one of the BPD participants had a history of at least one suicide attempt, while 29 had never attempted suicide. The full sample had a mean age of 37.4 ± 13.0 with a range of 18 — 69, and was 71.1% female. All participants were of either Hispanic (17.4%) or non-Hispanic Caucasian (82.6%) descent. We limited the racial and ethnic composition of the sample in an effort to reduce the possibility of sample stratification. Exclusion criteria for the patient group were the presence of persisting psychotic symptoms or psychotic disorder diagnosis, history of severe head trauma, or the presence of mental retardation or any cognitive impairment that might interfere with the completion of the assessments or the obtaining of informed consent. The study was approved by the institutional review boards of Columbia University and the University of Pittsburgh Medical Center, and all participants provided written informed consent.

Measures

Diagnoses were determined using the Structured Clinical Interview for DSM-III-R/DSM-IV, Patient Edition (Spitzer et al. 1990) and the Structured Clinical Interview for DSM-IV Axis II Personality Disorders (First et al., 1995). Impulsiveness was assessed using an early draft of the eleven-item version of the Barratt Impulsiveness Scale (BIS-11, Barratt, 1994). The BIS-11 is a 30-item self-report questionnaire designed to measure levels of trait impulsivity with demonstrated reliability and validity. It contains three subscales that assess Attentional, Motor, and Nonplanning Impulsiveness. Hostility was assessed using the Buss-Durkee Hostility Inventory (BDHI) (Buss and Durkee, 1957). The BDHI is a 75-item self-report questionnaire designed to measure several aspects of hostility. The scale is comprised of seven subscales (66 items) plus an additional Guilt subscale (9 items) that is not included in the total score. We also grouped these subscales into two factors, based on the results of the original factor analysis by Buss and Durkee: an attitudinal hostility component (AH), which was computed as the mean of the Resentment, Suspicion, and Guilt scales, and a behavioral aggression component (BA), which was computed as the mean of the Assault, Indirect Hostility, Irritability, Verbal Hostility, and Negativism scales. The BDHI is also a very widely used measure of hostility and aggression with demonstrated reliability and validity. All interviews were conducted by clinicians with at least a Master's degree and with extensive training in the use of the SCID instruments and clinical measures. Diagnoses were finalized at a consensus conference where all clinical and research material was reviewed by senior investigators.

Genotyping

DNA was extracted from lymphocytes as described by Huang et al. (2003) and from epithelial cells from cheek swabs (according to the manufacturer's procedure), and amplified via polymerase chain reaction (PCR). PCR amplification was performed in 20 μ l of reaction mixture containing 1x PCR buffer, 40-100 ng DNA, 2 mM $MgCl_2$, 4% of DMSO (dimethyl sulfoxide), 50 nM of each dNTP, 0.8 U RedTaq polymerase (Sigma, St Louis, MO), and 40 ng of each primer. Forward primer (Mann-45), 5'-GCCAGGAATTCATCAATGG-3', and reverse primer (Mann-46), 5'-CCACCACATACACCCAAA-3' were used. The reaction conditions were as follows: 95°C for 4 min, 30 cycles at 95°C for 40 s, 40 s at 54°C, 40s at 72°C and a final extension step at 72°C for 3 min. PCR amplifications were performed in a DNA Robocycler (Stratagene, La Jolla, CA). PCR fragment (508 bp) was digested with the *NheI* restriction enzyme as described by Nielsen et al. (1997). Electrophoresis was performed in 1.4% agarose and the PCR amplification products visualized with UV light.

Data Analysis

Means and standard deviations were computed for all variables in the analyses, and all variables were checked for normality and outliers. In order to test for group differences on

the demographic variables, chi-squares were computed for gender and race (Hispanic versus non-Hispanic), and a t-test for independent samples was computed for age. Chi-squares were computed for an additive model (genotype), as well as for a dominant risk allele model (AA/AC versus CC). We computed two chi-squares in order to test two comparisons: one for BPD patients versus healthy controls, and a second for BPD attempters versus BPD non-attempters. Differences in the levels of self-reported impulsiveness and hostility were analyzed with univariate ANOVA, comparing both the risk allele groupings (AA/AC versus CC) and genotypes in the full sample as well as in the individual comparison groups. All significant comparisons ($p < .05$) were reevaluated with a Bonferroni-corrected p-value of .007 (for 7 tests per comparison). Finally, we used the Generalized Linear Model to run a logistic regression analysis of the relationship between genotype and BPD status, controlling for age and gender.

Results

Participant Demographics

Demographic information comparing the two groups is presented in Table 1. The BPD group was younger than the control group and had more females. There was no significant difference in genotype frequencies between racial groups ($\chi^2 = <1.0$, $df = 1$, $p = ns$), or between males and females in the full sample ($\chi^2 = 2.46$, $df = 2$, ns), the patient group ($\chi^2 = <1.0$, $df = 1$, ns), or the control group ($\chi^2 = 1.87$, $df = 2$, ns). As a result, these groups were combined for all analyses.

Genotype and Allele frequencies

Genotype frequencies and statistics are presented in Table 2. Genotypes were in Hardy Weinberg equilibrium in the full sample ($\chi^2 = 0.07$, $df = 2$, $p = .96$) as well as in cases ($\chi^2 = 3.24$, $df = 2$, $p = .20$) and controls ($\chi^2 = 1.76$, $df = 2$, $p = .42$) independently. As an additional data check, we examined HWE in males and females in the full sample, and found no deviations (males $\chi^2 = 1.10$, $df = 2$, $p = .58$; females $\chi^2 = 1.02$, $df = 2$, $p = .60$). When comparing BPD cases and controls, the BPD group had a higher frequency of A allele carriers (AA/AC genotypes) than the control group ($\chi^2 = 6.12$, $df = 1$, $p = .01$). There was a significant difference in genotype frequencies as well ($\chi^2 = 7.10$, $df = 2$, $p = .03$), with an excess of heterozygotes in the BPD group. There was no significant difference in gene frequencies between suicide attempters and non-attempters within the BPD group ($\chi^2 = 1.22$, $df = 2$, $p = .54$). Genotype frequencies in the controls were similar to data published from the HapMap project on the CEPH population (genotype frequencies: AA = .186, AC = .424, CC = .390), which is a population from Utah with primarily northern and western European ancestry (Thorisson et al., 2005). This was not the case with the BPD group, which had fewer of the more common CC genotype and a higher frequency of heterozygotes relative to the HapMap data.

Diagnosis and Genotype

We conducted two logistic regression analyses predicting BPD diagnosis and by genotype, controlling for sex and age. The first model, predicting BPD diagnosis by allele group (AA/AC versus CC) was significant ($\chi^2 = 24.96$, $df = 3$, $p < .000$). TPH1 allele group predicted BPD after controlling for age and sex (Wald = 4.51, $df = 1$, $p = .03$). Carriers of the A allele were at increased risk for BPD. The second model, predicting BPD diagnosis by all three A218C genotypes, was also significant ($\chi^2 = 25.30$, $df = 4$, $p < .000$). In contrast to the first analysis, the test statistic for genotype main effect did not reach significance (Wald = 4.85, $df = 2$, $p = .09$). However, the individual parameter estimates suggest that A218C heterozygotes (AC) had the highest risk for BPD (Wald = 4.84, $df = 1$, $p = .03$).

Traits and Genotype

Impulsiveness and hostility scores by genotype in the full sample, and then separately for patient and control groups are in Tables 3-5. As expected, impulsiveness and hostility scores were higher in patients compared with controls. In the full sample, participants with the AC genotype had the highest scores on all measures. There were significant differences in means for Attentional Impulsiveness and the BDHI-AH scores, as well as trends for BIS Total Impulsiveness, Motor Impulsiveness, and BDHI Total Hostility (although neither comparison was significant after Bonferroni correction). However, none of the associations with genotype were found in either the cases or controls independently, suggesting the association between TPH1 and the traits found in the full sample may have been an artifact resulting from the relationship between genotype and diagnosis. To test this hypothesis, we conducted stepwise multiple regression analyses of impulsiveness and hostility, including age, gender, and genotype first and then adding in diagnosis. In the first analysis predicting BIS total score there were significant effects for age ($t=-3.51$, $df=1$, $p=.001$) and diagnosis ($t=-10.92$, $df=1$, $p<.000$), but not genotype. Results for the BDHI total score were similar, with significant effects for age ($t=-2.21$, $df=1$, $p=.03$) and diagnosis ($t=9.29$, $df=1$, $p<.000$), but not for genotype. In both analyses, BPD diagnosis predicted a substantial proportion of the variance in the traits, and rendered the contribution of genotype nonsignificant.

Discussion

We found that BPD patients were more likely to have at least one A allele compared with healthy controls. These results remained significant even after controlling for age and gender differences in the sample. The main difference in genotype frequencies seemed to stem from an increase in heterozygotes, with 59.0% of BPD patients in this group versus 42.6% of healthy controls, with a corresponding decrease in wild type (CC) homozygotes in the BPD group. This finding is consistent with recent research that has linked this polymorphism with BPD, or with behaviors associated with the disorder.

For example, in a study comparing Swedish women with BPD and a history of suicide to matched healthy controls, Zaboli and colleagues (2006) reported an association between TPH1 and BPD using SNPs located in a region located between the gene promoter and intron 3, including the A218C polymorphism. Although they did not report an association between any individual SNPs and the disorder, their six-SNP haplotype analysis yielded several strong associations. Our results are somewhat difficult to reconcile with theirs, mainly because of substantial differences in gene frequencies in the A218C polymorphism. Differences in population structure may have influenced this discrepancy, as their population was entirely from Sweden while ours was a more heterogeneous group of whites with presumed western European ancestry.

In another study comparing a mixed diagnostic group with a history of deliberate self-harm and healthy controls, Pooley and colleagues (2003) reported an association between the self-harming group and the A allele of the A779C SNP. Similar to our findings, the self-harm group was distinguished by an excess of heterozygotes (relative to HWE genotype frequencies). However, several issues make comparisons with this study difficult as well. First, the authors did not distinguish between suicidal and non-suicidal self-injurious behavior, and thus could not definitively determine whether the polymorphism was associated with suicide or non-suicidal self-injury. Also, the authors did not assess for Axis II disorders, and thus could not determine whether it was a BPD diagnosis that was driving the association. Although self-injury occurs most frequently in BPD, it is also associated with a number of other Axis I and II disorders (Gardner and Garnder, 1975; Bongar et al., 1990; Langbehn and Pfohl, 1993).

Findings on the association between TPH1 and BPD-related traits have been mixed. We found no relationship between TPH1 genotype and the traits of impulsiveness and hostility independent of BPD. These findings are consistent with several other studies that have also reported a lack of association between TPH1 and both impulsiveness (Nielsen et al., 1994; Evans et al., 2000) and hostility (Manuck et al., 1999). However, they also conflict with findings from several studies that have reported significant associations. For example, two studies from the same research group reported an association between A779C genotype and the BDHI subscales of Indirect Hostility and Negativism (Reuter and Hennig, 2005), and Aggressive Hostility, one of two types of hostility that were derived via a factor analysis (the other was called Neurotic Hostility) (Hennig et al., 2005). Although the authors of these studies reported that their samples were free from history of psychopathology, it is unclear whether they screened for Axis II pathology. As the means reported for the BDHI subscales of Negativism and Indirect Hostility in Reuter and Hennig are very similar to those found in our BPD group, it is possible that some level of Cluster B pathology may have influenced the association in their sample. New and colleagues (1998) also reported a significant association between BDHI scores and a TPH1 intron 7 polymorphism in males with a range of Axis II diagnoses, including some with BPD. However, the sample in that study consisted of only males and was relatively small, thus limiting comparison with our results. Like the two studies mentioned above, the level of Cluster B pathology in their groups is unclear, and thus may also have contributed to their findings.

Notably, genotype and allele frequencies were not significantly different between patients with and without a history of suicide attempts. Although the samples for this comparison are relatively small, the results suggest that our overall findings were not driven by an association between the polymorphism and suicidal behavior. TPH1 polymorphisms have been extensively studied as predictors of suicide risk, also with mixed results. While many studies (Nielsen et al., 1998; Abbar et al., 2001; Turecki et al., 2001) have reported an association between suicidal behavior and intron 7 polymorphisms or haplotypes, several well-designed studies, in agreement with our results, found no association (Kunugi et al., 1999; Du et al., 2000; Soury et al., 2001). As many studies examining this relationship did not assess for Axis II and thus did not control for BPD diagnoses, or did not include a nonsuicidal psychiatric control group, conflicting findings could be a reflection of varying rates of BPD in the patient groups. In addition, the nonsignificant difference between attempter and nonattempter genotypes in our study could also be suggesting that TPH1 is related to a trait that is present in suicide attempters across diagnostic groups, but which is present in both BPD attempters and nonattempters. This would reconcile the findings of this research with our previous report that suicide attempts in major depression are associated with TPH1 (Mann et al., 1997).

Although the comparison was not significant, we found the AC genotype frequency to be highest in suicide attempters. This is not entirely consistent with the conclusions of a recent meta-analysis of the association between TPH1 and suicidal behavior, which found a dose dependent increase in suicide risk associated with the A allele of the A218C polymorphism (Bellivier et al., 2004). While seemingly conflicting, this finding may actually be suggesting that it is the BPD attempters who are homozygous for the A allele that have the highest risk of completed suicide. This would lead to a selection pressure against AA genotypes, and lead to a reduction in their frequency in a population of suicide attempters. The fact that the genotype and allele frequencies in the BPD attempter group show a reduction in homozygotes and an increase in heterozygotes (relative to HWE) to a degree that is not seen in any of the other subgroups ($\chi^2=4.08$, $df=2$, $p=.13$) suggests that this could be the case. In addition, post-hoc analyses of the lifetime maximum lethality of suicide attempt in our sample showed that the AA genotype attempters made attempts of significantly higher lethality than attempters with the other two genotypes (4.5 ± 1.8 versus 3.0 ± 1.6 and 3.0 ± 1.8

for AC and CC respectively, $F(3,60)=2.78$, $p=.03$), also suggesting that the AA group may have the highest risk. This finding is consistent with our reports that serotonin deficiencies are found in more lethal suicide attempters with major depression (Malone et al., 1996; Mann and Malone, 1997; Oquendo et al., 2003). Future research comparing attempters and nonattempters in patients with and without BPD will be helpful in evaluating the relationship between TPH1 and suicidal behavior across diagnostic groups.

The mechanism by which TPH1 function or expression could influence serotonin levels in the CNS is not known. TPH2 is the predominant isoform in the adult CNS, while TPH1 is primarily active in the periphery (Sakowski et al., 2006). However, animal studies have shown that TPH1 is expressed much more prominently in the brain during the late prenatal period, and that it appears to play a role in determining the effect of serotonin on neuron number and growth (Rind et al., 2000; Nakamura et al., 2006). This developmental effect may be the mechanism by which TPH1 influences CNS serotonergic functioning in adult brain, thereby affect behavior and psychopathology in adulthood. While there are no studies examining the developmental effect of TPH1 polymorphisms, a recent study of the relationship between TPH1 and whole blood serotonin levels in family members of children with autism reported a moderate association with a TPH1 two-SNP haplotype that included the A779C polymorphism (Cross et al., 2008). Results showed that the haplotype under study, which included the A allele of the A779C polymorphism, was associated with increased serotonin levels in a dose-dependent manner, and suggest that TPH1 polymorphisms could also have an effect on prenatal serotonin levels as well.

This study has several limitations. First, the modest sample size, as well as the fact that we focused on a single polymorphism, means our findings must be replicated and validated. While single locus studies are often difficult to replicate, the large literature on the A218C polymorphism and the findings suggesting TPH1 polymorphisms are related to behaviors and traits typically found in BPD samples increases the likelihood that our findings are valid. In addition, while our sample is relatively well-characterized, we did not control for ancestry beyond European white decent. As TPH1 allele frequencies vary even between northern and southern Europe (Nielsen et al., 1997), it is possible that there is unknown stratification in our sample that is contributing to the results. Finally, the absence of a non-BPD psychiatric control group and the high rate of mood disorder co-morbidity in this population meant we could not determine the role of mood disorders in the findings. However, the fact that recent research on TPH1 polymorphisms and bipolar disorder (Preisig, Ferrero, & Malafosse, 2005) and major depressive disorder (Kunugi, Ishida, Kato, et al., 1999; Bennett, McMahon, Watabe, et al., 2000;) has concluded that TPH1 is not related these disorders suggests that comorbidity did not significantly influence our results.

Despite these limitations, our results suggest that the TPH1 A218C polymorphism is related to a diagnosis of BPD, independent of suicide attempter status. In addition, and contrary to several other reports, our findings did not support a relationship between TPH1 and impulsiveness or hostility. These results suggest that some other aspect of BPD pathology is likely due in part to serotonergic dysfunction related to TPH1 effects.

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TABLE 1

Demographic Characteristics by Group

Characteristic	BPD (<i>n</i> = 100)	Control (<i>n</i> = 101)	<i>t</i> / χ^2	df
Age (yr)	34.2±10.6	40.5±14.4	-3.56***	199
Female (%)	81 (81.0)	62 (61.4)	9.42**	1
Race (%)				
Non-Hispanic	78 (78.0)	77 (87.1)	2.91 ^a	1
Hispanic	22 (22.0)	13 (12.9)		

Note. BPD = Borderline Personality Disorder.

^a
p < .10

*
p < .05

**
p < .01

p < .00.

TABLE 2

Genotype and Allele Frequencies by Group

Group	Additive Model					Dominant Risk Allele Model				
	AA (%)	AC (%)	CC (%)	A (%)	C (%)	χ^2	df	AA/AC (%)	CC (%)	χ^2
BPD ($\bar{n}$ =100)	21 (21.0)	59 (59.0)	20 (20.0)	.505	.495	7.10 *	2	80 (78.0)	20 (20.0)	6.12 *
Controls ($\bar{n}$ =101)	22 (21.8)	43 (42.6)	36 (35.6)	.431	.569			65 (64.4)	36 (35.6)	
Attempter ($\bar{n}$ =71)	13 (18.3)	44 (62.0)	14 (19.7)	.493	.507	1.22	2	57 (80.3)	14 (19.7)	<1.0
Nonattempter ($\bar{n}$ =29)	8 (27.6)	15 (51.7)	6 (20.7)	.534	.466			23 (79.3)	6 (20.7)	

Note. BPD = Borderline Personality Disorder.

*
 $p < .05$.

TABLE 3

Impulsiveness and Aggression — Full Sample ($N = 188$)

	AA (UU)	AC (UL)	CC (LL)	F	df
BIS Total Score	43.3±17.5	50.2±21.0	43.4±21.0	2.67 ⁺	2, 185
BIS Attentional Impulsiveness	11.2±6.5	13.7±6.4	10.9±6.4	4.02 [*]	2, 185
BIS Motor Impulsiveness	14.1±6.5	16.3±8.8	13.2±7.4	2.89 ⁺	2, 185
BIS Nonplanning Impulsiveness	18.1±8.4	20.3±8.6	19.4±9.9	< 1.00	2, 185
BDHI Total Score	29.2±5.4	32.5±10.7	27.0±10.5	2.72 ⁺	2, 185
BDHI-AH	6.8±5.9	8.2±5.4	6.1±4.2	3.03 [*]	2, 185
BDHI-BA	18.8±8.2	20.2±8.0	17.6±7.3	1.93	2, 185

Note. BIS = Barratt Impulsiveness Scale; BDHI = Buss-Durkee Hostility Inventory.⁺ $p < .10$ ^{*} $p < .05$.

TABLE 4

Impulsiveness and Aggression — Healthy Controls (n=98)

	AA (UU)	AC (UL)	CC (LL)	F	df
BIS Total Score	34.1±13.1	35.0±12.8	35.7±15.7	< 1.00	2, 95
BIS Attentional Impulsiveness	8.5±5.0	9.4±4.9	8.7±5.0	< 1.00	2, 95
BIS Motor Impulsiveness	11.0±5.1	11.4±6.3	10.1±4.9	< 1.00	2, 95
BIS Nonplanning Impulsiveness	14.2±6.1	14.6±5.1	16.9±8.5	1.47	2, 95
BDHI Total Score	17.9 ±9.6	22.7±11.4	21.1±7.7	1.63	2, 95
BDHI-AH	2.9±3.1	4.5±3.8	4.4±2.8	1.74	2, 95
BDHI-BA	13.3±5.7	15.8±7.5	14.5±5.5	1.09	2, 95

Note. BIS = Barratt Impulsiveness Scale; BDHI = Buss-Durkee Hostility Inventory.

TABLE 5

Impulsiveness and Aggression — Clinical Sample ($n = 90$)

	AA (UU)	AC (UL)	CC (LL)	F	df
BIS Total Score	54.6±15.8	61.7±18.5	59.5±21.9	< 1.00	2, 87
BIS Attentional Impulsiveness	14.5±6.8	16.9±5.5	15.3±6.8	1.21	2, 87
BIS Motor Impulsiveness	17.3±6.7	20.2±8.4	19.6±7.6	< 1.00	2, 87
BIS Nonplanning Impulsiveness	22.8±8.6	24.6±8.2	24.6±10.8	< 1.00	2, 87
BDHI Total Score	41.52±11.0	39.6±12.4	39.4±10.1	< 1.00	2, 87
BDHI-AH	11.2±5.3	11.0±4.7	9.9±4.2	< 1.00	2, 87
BDHI-BA	24.7±6.1	23.3±6.8	24.3±6.2	< 1.00	2, 87

Note. BIS = Barratt Impulsiveness Scale; BDHI = Buss-Durkee Hostility Inventory.