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BDNF and stress/mood-related interactions on emotional disorder symptoms, executive functioning, and deliberate self-harm

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Abstract

Some prior research has suggested that the brain-derived neurotrophic factor (*BDNF*) gene may amplify responses related to life stress (e.g., depression and anxiety) or associated with negative moods (e.g., self-harm and diminished cognitive functioning). The purpose of this study was to investigate whether stress/mood-related associations with depressive and anxiety symptoms, deliberate self-harm, and executive functioning (EF) are moderated by genotypic variations in *BDNF* rs10835210 (a relatively understudied *BDNF* polymorphism) in a nonclinical sample. As part of a larger study, European American social drinkers (N = 132; 43.9% female; M age = 26.0, SD = 7.6) were genotyped for *BDNF* rs10835210 and were administered self-report measures of subjective life stress, depressive and anxiety symptoms, and history of non-suicidal self-injury (NSSI) and behavioral measures of EF and deliberate self-harm. Results indicated that *BDNF* significantly moderated the life stress associations with depressive symptoms and NSSI, the anxious mood association with EF, and the depressed mood association with deliberate self-harm behavior. Each of these *BDNF* × stress/mood interactions were characterized by stress/mood associations that were stronger in individuals with the AA genotype (homozygous for the minor allele) than in individuals possessing a genotype that included the major allele (AC or CC). The

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Declaration of competing interest
None.

CRediT authorship contribution statement
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main limitations of the present study were use of a cross-sectional design, modest sample size, and investigating only one *BDNF* polymorphism. Despite these limitations and though preliminary, current findings suggest that variations in *BDNF* may confer vulnerability to stress or mood, which may result in more adverse emotional, cognitive, or behavioral outcomes.

Keywords

brain-derived neurotrophic factor (*BDNF*) gene; depression; anxiety; executive functioning; deliberate self-harm

1. Introduction

Depressive and anxiety symptoms often co-occur (Jacobson and Newman, 2017) and have been concurrently and prospectively associated with impairments in executive functioning (EF; Zainal and Newman, 2020, 2022). Depressive and anxiety symptoms also have been associated with deliberate self-harm ranging from non-suicidal self-injury (NSSI) to suicide attempts (Favril et al., 2020; Fox et al., 2015; Victor and Klonsky, 2014). In addition, twin-based studies have evidenced that depressive and anxiety symptoms are moderately influenced by genetic factors (Gustavson et al., 2019) and display strong genetic correlations with each other as well as modest genetic correlations with EF and deliberate self-harm (Gustavson et al., 2019; Lim et al., 2022).

Given that emotional disorder symptoms (e.g., depression and anxiety) often co-occur and share genetic liability with EF deficits and deliberate self-harm, it is possible that associated genes may contribute to these conditions. One gene, called the brain-derived neurotrophic factor (*BDNF*) gene, encodes a protein that regulates synaptic plasticity, promotes dendritic growth, and plays a role in mood and cognition (Autry and Monteggia, 2012; Hing et al., 2018). Of the *BDNF* genetic polymorphisms, rs6265, a missense mutation (Val66Met), most often has been studied and across two meta-analyses has evidenced associations with panic disorder (Chen et al., 2017) and suicidal behavior (Gonzalez-Castro et al., 2017), which in both cases was an association with individuals homozygous for the minor allele (A). However, meta-analyses have not related the *BDNF* rs6265 polymorphism to major depressive disorder (Li et al., 2016) or EF (Mandelman and Grigorenko, 2012). Yet, other more recent research suggests that *BDNF* interactions with stress-related factors may be better predictors of emotional disorder symptoms, deliberate self-harm, and EF (Hing et al., 2018). In particular, meta-analyses have evidenced that the minor allele of *BDNF* rs6265 may strengthen life stress associations with depression (Hosang et al., 2014; Zhao et al., 2018), and one recent study evidenced that *BDNF* rs6265 may interact with depressive emotionality in relating to worse EF (Sanwald et al., 2020). Thus, some prior work suggests that variations in *BDNF* may increase vulnerability both to the effects of life stress on depression and to the effects of negative mood on EF.

Notably, the minor allele for another less studied *BDNF* polymorphism, rs10835210 (minor/major allele: A/C), has been associated with internalizing disorders among Chinese young adults (Meng et al., 2009; Xie et al., 2011). Also, in more recent research involving individuals of European ancestry, the AA genotype of *BDNF* rs10835210 was associated

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with anxiety disorders (McGregor et al., 2018) and worse performance on the Trail Making Test (TMT; Wilkosc et al., 2016). Furthermore, *BDNF* rs10835210 interacted with childhood trauma in relating to anxiety disorders (McGregor et al., 2018) and was associated with a history of suicide attempts in patients with a substance use disorder (Icick et al., 2021). In the Icick et al. (2021) study in particular, the researchers additionally found that the minor allele (A) of *BDNF* rs10835210 was associated with higher levels of BDNF antisense (AS) mRNA in the frontal cortex due to the increased expression of the *BDNF-AS* gene, which inhibits BDNF transcription and reduces endogenous BDNF protein; thus, the researchers speculated that their findings may exemplify a stress-diathesis model (i.e., an adverse interaction between chronic drug use and *BDNF* gene expression), similar to what might be seen in other individuals impacted by environmental and/or neurobiological stress (e.g., individuals exposed to traumatic events or experiencing depression). Generally in accord with this idea, meta-analyses have associated stressful life events with emotional disorder symptoms (Lindert et al., 2014; March-Llanes et al., 2017) and NSSI (Liu et al., 2016), and both depression and anxiety have been implicated as risk factors in the development of deliberate self-harm behaviors (Fox et al., 2015; Liu et al., 2016; Victor and Klonsky, 2014). Taken together, the evidence above suggests that *BDNF* may moderate stress-related associations with depression, anxiety, and deliberate self-harm, and may further moderate mood-related associations with deliberate self-harm and worse EF. Except for anxiety, however, to our knowledge no prior study has investigated these possibilities in relation to *BDNF* rs10835210.

Hence, the present study investigated if stress/mood-related associations with emotional disorder symptoms, deliberate self-harm, and EF are moderated by genotypic variations in *BDNF* rs10835210 in a nonclinical sample of European Americans. We hypothesized that *BDNF* would moderate life stress associations with depression, anxiety, and deliberate self-harm (indexed by self-reported history of NSSI and performance on a behavioral task of deliberate self-harm), and we further hypothesized that *BDNF* would moderate depressed and anxious mood associations with deliberate self-harm and worse EF. More specifically, we hypothesized that these relations would be stronger in the presence of the AA genotype, given that prior research has indicated a recessive model of genetic risk may best fit the *BDNF* polymorphic data (Chen et al., 2017; Icick et al., 2021; McGregor et al., 2018; Perez-Rodriguez et al., 2017).

2. Material and methods

2.1. Participants and procedures

Participants were 132 European American social drinkers recruited from the community (Hattiesburg, MS, USA) for a larger experimental study focused on the effects of alcohol on deliberate self-harm behavior (Berman et al., 2017). The current study involves a secondary analysis of self-report and behavioral data collected as part of the larger experimental study (2006–2008) which then was combined with data from additional genotyping that was later conducted on dried blood samples (in 2015). During a preliminary phone interview, exclusion criteria included reporting a history of bipolar or psychotic disorder, past 6-month anxiety or depressive disorder, or another severe psychological problem that currently

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required treatment. Potential participants were also excluded over the phone if they scored 10 or higher on the Alcohol Use Disorders Identification Test (AUDIT; Babor et al., 2001) or if they reported never having consumed alcohol (to limit the sample to social drinkers). Then as part of a subsequent laboratory session, eligible participants completed self-report measures, provided blood for genotyping, and were administered the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999), which was included only for potential use as a covariate if there were IQ differences between genotypic groups. On a separate day, participants were administered behavioral measures, including the TMT and a laboratory task that assessed deliberate self-harm behavior (administered by trained clinical psychology doctoral students under the supervision of Dr. Mitchell E. Berman).

Although 222 participants were initially genotyped for *BDNF* rs10835210, only European American individuals were retained (to restrict the possibility of confounding due to population stratification). Of the remaining 144 individuals, 12 were excluded because of lacking self-report data, leaving a final sample of 132 European American participants (with behavioral data available for 126 participants). All participants were provided with written informed consent, which they signed after reading the document and having the study procedures fully explained to them. The University of Southern Mississippi Human Subjects Protection Review Committee approved the procedures for the larger study (Protocol 24110801, "Effects of Alcohol on Human Self-Aggressive Behavior"), which was conducted in accordance with the tenets of the Declaration of Helsinki.

2.2. Self-report measures

2.2.1. PTSD Checklist Civilian Version (PCL-C)—The 17-item PCL-C (McDonald and Calhoun, 2010; Ruggiero et al., 2003) assesses symptoms associated with post-traumatic stress disorder. However, the PCL-C is not specific to trauma, as respondents are instructed to rate how much they have been bothered during the past month by each "response to stressful life experiences" on a severity scale ranging from 1 (*not at all*) to 5 (*extremely*). Given that the PCL-C (without additional trauma assessment) is related more broadly to a person's subjective responses to stressful life experiences in general (which include but are not limited to traumatic stress), in the current study we used higher PCL-C sum scores as a proxy for more intense life stress.

2.2.2. Depression Anxiety Stress Scales (DASS)—From the 42-item version of the DASS (Lovibond and Lovibond, 1995), the DASS Depression scale (14 items) and the DASS Anxiety scale (14 items) were respectively used to assess depressive and anxiety symptoms experienced during the past week. Items are scored from 0 (*Did not apply to me at all*) to 3 (*Applied to me very much, or most of the time*), with higher sum scores indicating more depressed or anxious mood. The DASS Depression and Anxiety scales have evidenced excellent convergent and discriminant validity, both in relation to other self-report measures of depression and anxiety in nonclinical samples (Bilgel and Bayram, 2010; Crawford and Henry, 2003) and in relation to depressive and anxiety disorder diagnoses and symptom severity in clinical samples (Antony et al., 1998; Brown et al., 1997).

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2.2.3. Deliberate Self-Harm Inventory (DSHI)—The 17-item DSHI (Gratz, 2001) assesses lifetime history of NSSI. Items ask if respondents have ever engaged in NSSI, such as cutting, burning, or otherwise injuring oneself (0 = *No*; 1 = *Yes*). Thus, higher DSHI sum scores indicate lifetime engagement in a larger number of different kinds of NSSI.

2.2.4. Schedule for Nonadaptive and Adaptive Personality-2 (SNAP-2)—The 28-item SNAP-2 (Clark et al., 2014) Negative Temperament scale assesses trait negative affectivity (i.e., the general tendency to experience negative mood and affectively react more strongly to minor stressors). True/false responses are scored 0 or 1, with higher sum scores indicating greater trait negative affectivity (used only as a covariate in certain analyses).

2.3. Behavioral measures

2.3.1. Trail-Making Test (TMT)—The TMT (Stern and Prohaska, 1996) is a pencil-and-paper task consisting of two parts. During Part A (TMT-A), participants must connect 25 numbers in order, but during Part B (TMT-B), participants must connect 25 numbers and letters in alphanumerical order; and completion times are recorded for each. Whereas the TMT-A is primarily a measure of visual processing speed, the TMT-B has been shown to index set shifting, a form of EF. Thus, greater TMT-A and TMT-B completion times indicate slower visual processing speed and worse EF, respectively. Though we were primarily interested in EF, we also included visual processing speed in moderation analyses.

2.3.2. Self-Aggression Paradigm (SAP)—The SAP (Berman et al., 2017) is a laboratory task that assesses deliberate self-harm behavior. During the SAP, participants are given the opportunity to self-administer electric shock each time they “lose” a trial in a “competitive reaction-time task” against a fictitious opponent (40 trials with equal wins and losses). The intensity of self-administered shock is completely under the participant’s control, including 0 (no shock), from 1 (a barely noticeable shock level) to 10 (a shock level previously judged as slightly painful), and lastly the 20-shock, which the participant is told is twice as intense as the 10-shock and “may cause minor tissue damage.” In actuality, however, the 20-shock is the same intensity as the 10-shock. Deliberate self-harm behavior was defined as the frequency of self-selected 20-shocks (range: 0–20). The validity of SAP 20-shock frequency as a measure of deliberate self-harm is supported by correlations with self-reported NSSI history and acute increases associated with serotonergic disruption and alcohol intoxication (Berman et al., 2017).

2.4. BDNF rs10835210 Genotyping

Dried blood specimens were analyzed at the Indiana Alcohol Research Center. DNA was isolated using the HotSHOT method (Truett et al., 2000). TaqMan probe was purchased from Life Sciences. Because genotyping was done by endpoint reading, thermocycling was conducted in MJ Research PTC-200 thermocyclers, and PCR products were analyzed in an ABI PRISM® 7300 Sequence Detection System (SDS) instrument. SDS Software 1.4.0 converted the raw data to pure dye components and plotted the results of allelic discrimination on a scatter plot of Allele X versus Allele Y.

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2.5. Data Analysis

After conducting preliminary analyses (detailed below), we next conducted moderated regression analyses using Model 1 of the PROCESS macro (v4.0) for SPSS (Hayes, 2022), in which we first tested *BDNF* genotypic group (CC/CA = 0, AA = 1) as a potential moderator of life stress associations with depressive and anxiety symptoms, history of NSSI, and deliberate self-harm behavior (i.e., tested potential *BDNF* × life stress interactions). Similarly, we then tested *BDNF* genotypic group as a potential moderator of depressed and anxious mood associations with TMT (A and B) performance and deliberate self-harm behavior (i.e., tested potential *BDNF* × mood interactions). In analyses involving life stress as the predictor, trait negative affectivity was used as a covariate (to account for the possible confound of the general tendency to experience negative mood symptoms and react more strongly to daily stressors), and in analyses involving depressed or anxious mood as the predictor, co-occurring anxiety or depression was used as a covariate (to see if any depressed or anxious mood interactions are unique from other mood symptoms). For each statistically significant association, the standardized regression coefficient (β) is reported, and for each significant interaction effect, change in R^2 (or R^2 change) is reported as a measure of effect size.

To limit the possibility of Type I error, we adopted a stringent statistical significance level using the Bonferroni correction (α = .05/10 = .005) for each of the 10 moderated regression analyses. Due to the archival nature of the current sample, we conducted a post hoc statistical power analysis (one-tailed) using G*Power 3.1.9.7 (Faul et al., 2009) with a medium effect size of .10 for f^2 (Cohen, 1988), a sample size of 126, an α of .005, and four predictors in the linear regression model, which yielded a value of .82 for power. Thus, current sample sizes (i.e., 126 for behavioral data and 132 for self-report data) were evidenced as having sufficient statistical power in detecting moderate to strong effect sizes.

3. Results

3.1. Preliminary analyses

Descriptive statistics and Cronbach's alphas for self-report scales are shown in Table 1. The genotypic frequency distribution for *BDNF* rs10835210 (43 CC, 59 CA, 30 AA) did not deviate significantly ($\chi^2 = 1.25$, $p = .26$) from Hardy–Weinberg equilibrium (Rodriguez et al., 2009). Fisher's exact tests and independent samples *t*-tests revealed that *BDNF* genotypic groups (CC/CA vs. AA) did not differ significantly in respect to age, sex, years of education, marital status, or WASI Full Scale IQ score (each $p > .05$). Based on the standards set by Curran et al. (1996), the score distributions for the DSHI and TMT-B were moderately to severely non-normal (skewness = 3.2–3.7; kurtosis = 10.7–18.5); however, after using a logarithmic transformation (Lg10[DSHI + 1]) and a square root transformation (SQRT[TMT-B]) to normalize the distributions of the two variables, the statistical significance of findings was not altered. Therefore, only results from analyses using raw scores are presented.

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3.2. Moderated regression analyses

BDNF rs10835210 did not have significant main effects on depression, anxiety, NSSI history, visual processing speed, EF, or deliberate self-harm behavior (each $p > .015$). However, there were four significant *BDNF* × stress/mood interactions (detailed below and illustrated in Fig. 1 using a median split): *BDNF* × life stress interactions on depressive symptoms (β = .24, $p < .003$, R^2 change = .055) and history of NSSI (β = .34, $p < .001$, R^2 change = .11), a *BDNF* × anxious mood interaction on worse EF (β = .26, $p = .001$, R^2 change = .077), and a *BDNF* × depressed mood interaction on deliberate self-harm behavior (β = .24, $p < .004$, R^2 change = .067). No other *BDNF* × stress/mood interactions were statistically significant (each $p > .02$).

To elaborate on the significant interactions by reporting on the associated simple effects, in the presence of the *BDNF* AA genotype, life stress was strongly associated with depression (β = .71, $p < .001$) and NSSI history (β = .94, $p < .001$); anxious mood was highly related to worse EF (β = .59, $p < .001$); and depressed mood was highly related to deliberate self-harm behavior (β = .46, $p < .008$). Among the CC/CA genotypic group, however, life stress was weakly related to depression and NSSI history, and anxious and depressed mood were weakly related to EF and deliberate self-harm behavior (β = −.10 to .13; each $p > .20$).

4. Discussion

In the current sample, the life stress associations with self-reported depression and NSSI history, the anxious mood association with worse EF, and the depressive mood association with deliberate self-harm behavior were strengthened in the presence of the AA genotype of *BDNF* rs10835210. Though these findings are novel, they are in accord with the theory that interactions between *BDNF* gene variations and stress- or mood-related factors may alter DNA methylation and BDNF protein production, thereby increasing vulnerability to experiencing more negative emotions, cognitions, and behaviors (e.g., depressive states, thoughts of suicide, and suicide attempts; Hing et al., 2018). Hence, current findings suggest that *BDNF* rs10835210 may be a polymorphism of interest in regard to potential adverse *BDNF* × stress/mood interactions.

The present study evidenced a *BDNF* × life stress interaction on depressive symptoms. Though not specific to *BDNF* rs10835210, prior meta-analyses involving *BDNF* rs6265 similarly evidenced *BDNF* × life stress interactions on depression (Hosang et al., 2014; Zhao et al., 2018). In contrast, however, another study that included two large samples (numbering in the tens of thousands) found no significant *BDNF* rs6265 × life stress interactions on depression (Border et al., 2019). Therefore, in light of this conflicting evidence pertaining to *BDNF* rs6265, it is possible that the current *BDNF* × life stress interaction on depression was found due to investigating (a far less studied) *BDNF* polymorphism, rs10835210. Future research that genotypes rs10835210 (and other *BDNF* polymorphisms) in conjunction with assessing life stress in larger samples will be needed to better evaluate this possibility.

The current study's lack of support for a *BDNF* × life stress interaction on anxiety symptoms seemingly contradicts a previous study (McGregor et al., 2018) that evidenced

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an interaction of *BDNF* rs10835210 with childhood trauma in predicting adult anxiety disorders. However, in this other study (McGregor et al., 2018), less than 20% of patients were diagnosed with panic disorder. Thus, this may help explain the discrepancy in findings given that the DASS Anxiety scale has shown the strongest associations with panic disorder (Antony et al., 1998; Brown et al., 1997). Still, the current lack of a significant *BDNF* × life stress association with anxiety symptoms (paired with the significant *BDNF* × life stress association with depression) may suggest that that *BDNF*-related emotional vulnerability is more specific to depression.

Current findings also evidenced that anxious mood was related to worse EF (as indexed by TMT-B completion time) in the presence of the AA genotype of *BDNF* rs10835210. Unlike in the previous study conducted by Wilkosc et al. (2016), however, in the current study *BDNF* rs10835210 was not related to visual processing speed (TMT-A performance). Current results may differ from Wilkosc et al. (2016) due to age being highly correlated (r = .45) with TMT-A performance in their study; because Wilkosc et al. (2016) did not provide information regarding whether age differed across genotypic groups, it is possible that this contributed to the discrepant findings, given that ANCOVA (which they utilized) is unable to correct mean scores for group differences in age. Lastly, the fact that current *BDNF* × anxious mood association with worse EF remained statistically significant after adjusting for co-occurring depression (together with the *BDNF* × depressed mood association with EF not being statistically significant) may suggest that *BDNF*-related cognitive vulnerability is more specific to anxiety.

In the current nonclinical sample of European Americans, lifetime history of suicide attempts was not assessed. Speaking more broadly of deliberate self-harm, however, both the *BDNF* × life stress interaction on history of NSSI and the *BDNF* × depressed mood interaction on deliberate self-harm behavior found in the current study are generally concordant with a recent study (Icick et al., 2021) that associated the AA genotype of *BDNF* rs10835210 with a history of suicide attempts in substance use disorder patients of European ancestry, which may reflect a stress-vulnerability interaction (i.e., an interaction of the neurobiological stress of chronic drug use with *BDNF* gene expression). Additionally, in the same recent study (Icick et al., 2021), the A allele of *BDNF* rs10835210 was related to gene expression associated with reduced BDNF protein levels and functioning, which provides some evidence suggestive of a biological pathway whereby *BDNF* × stress/depression interactions may exert adverse behavioral effects. On the other hand, current findings did not evidence a significant *BDNF* × anxious mood interaction on deliberate self-harm behavior. Notably though, meta-analyses have more consistently evidenced stressful life events and depressive symptomatology as risk factors for deliberate self-harm (Fox et al., 2015; Liu et al., 2016; Victor and Klonsky, 2014).

4.1. Strengths and limitations

One strength of the current investigation is the use of a multi-modal (self-report and behavioral) assessment, including a behavioral measure of deliberate self-harm (a first for a genetic association study). In addition, genotypic variation in *BDNF* rs10835210 naturally is temporally precedent to the self-report and behavioral measures used in the current

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study, and thus it has a stronger case than some other (non-genetic) factors would for the potential to intensify stress-related responses (e.g., depression) and mood-related behaviors (e.g., deliberate self-harm). Nonetheless, the use of a cross-sectional design impedes our confidence in making inferences about the temporality and causality of associations. Another limitation of the current study is the use of the PCL-C (a measure of subjective responses to stressful life events) as a proxy for life stress. Some researchers would rightfully argue that "operationalizing stress based on subjective or cognitive appraisals of the stressfulness of an event…risks confounding environmental events with the individual's underlying diathesis" (such as neuroticism; pp. 2–3, Liu et al., 2016); however, in current analyses involving the PCL-C, we did statistically adjust for trait negative affectivity in order to account for the general tendency to experience negative mood and react more strongly to stressors, which should counter at least some concern about this issue. We also acknowledge that the PCL-C as a proxy for life stress cannot distinguish the timing of stressful events (e.g., childhood vs. adulthood), and thus it would be useful for future studies to include separate assessments among adults for childhood adverse or traumatic experiences and stressful life events experienced in adulthood. Another limitation of the current study is the sole inclusion of generally healthy European American social drinkers. This occurred in part because generally healthy social drinkers were recruited as part of the larger alcohol administration study, and then only participants who reported being of European descent were retained for the current study (which was done in order to restrict the possibility of confounding due to population stratification). Still, this limits the ability to generalize current findings to other populations, and thus it would be useful for future work to attempt to replicate current findings among individuals with other racial/ethnic ancestry regardless of their drinking habits. Additional limitations of the current study include the genotyping of a single polymorphism (rs10835210) in a modestly sized sample and only testing one model of genetic inheritance (the recessive model). Future studies that employ larger samples sizes (and thus have increased statistical power) and that genotype multiple *BDNF* and other genetic polymorphisms (in addition to *BDNF* rs10835210) would allow for testing alternative genetic models as well as potential gene × gene interactions (Li et al., 2021).

4.2. Conclusions and potential treatment implications

Despite these limitations, the current study still makes a worthwhile contribution to the literature. Some prior research has evidenced a potential role for the *BDNF* gene in increasing risk for negative stress-related emotional responses and mood-associated cognitive and behavioral responses, though most of this prior work has focused on one particular *BDNF* polymorphism (rs6265). With a relatively understudied *BDNF* polymorphism (rs10835210), the current study extends on this prior work by reporting *BDNF* × life stress associations with self-reported depression levels and NSSI history, a *BDNF* × anxious mood association with worse EF, and a *BDNF* × depressed mood association with deliberate self-harm behavior. Though preliminary, current findings suggest that variations in *BDNF* may confer vulnerability to stress or mood, which may result in more adverse emotional, cognitive, and behavioral outcomes. Presently, mindfulness-based programs (Galante et al., 2021; Im et al., 2021) and transcranial magnetic stimulation (Cirillo et al., 2019; Martin et al., 2017; McClintock et al., 2020) are two promising

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interventions for depression, anxiety, and associated deficits in EF. Perhaps a better future understanding of *BDNF* genetic risk and expression and BDNF brain signaling may ultiately lead to novel therapeutic interventions for emotional disorder symptoms and related behaviors (e.g., self-injurious behaviors) as well as associated impairments in cognitive functioning (Xu et al., 2021).

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Data availability statement

The data used to support the findings of this study are available from the corresponding author upon request.

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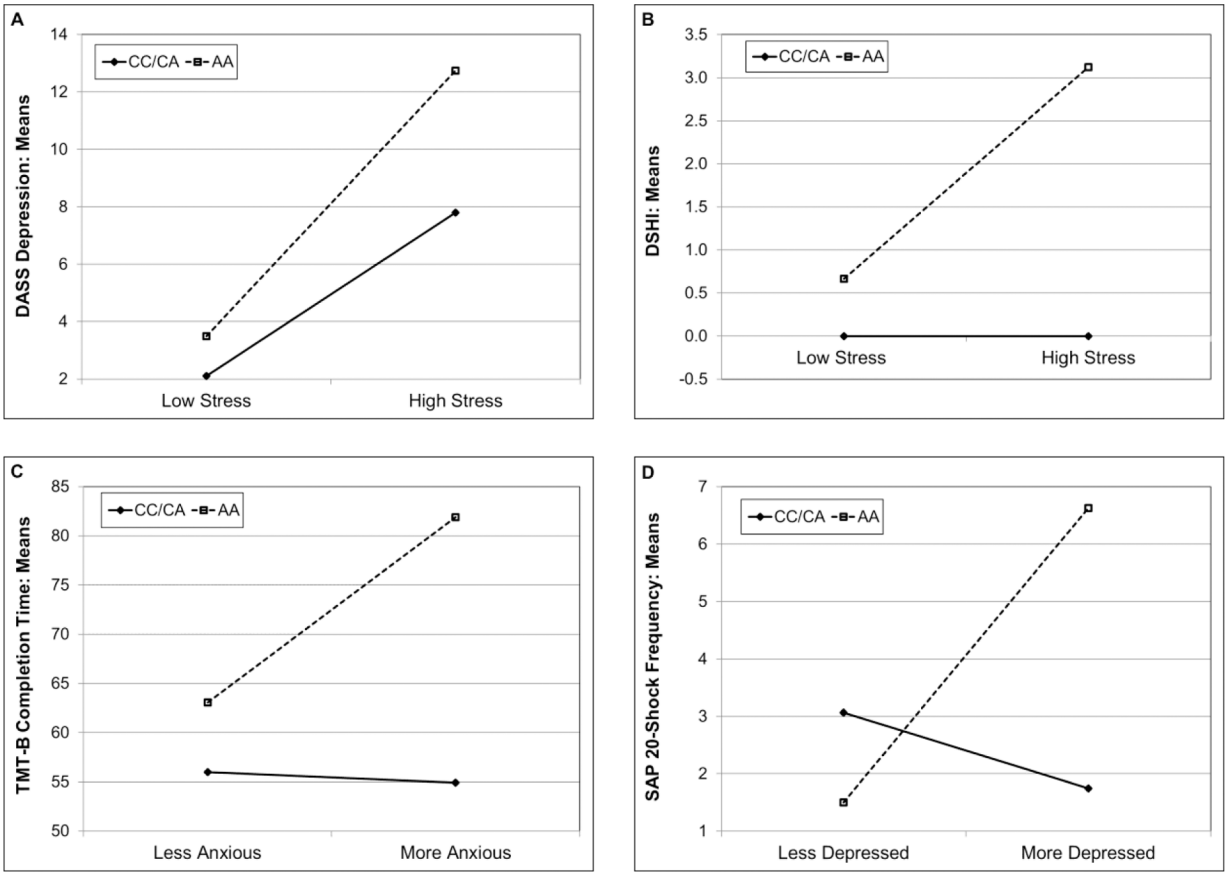

Fig. 1.

BDNF rs10835210 × stress/mood interactions (using a ± 1 *SD* split for low/high stress and less/more depressed and a ± 0.5 *SD* split for less/more anxious). PTSD Civilian Checklist (PCL-C) scores were used as a proxy for life stress, and DASS Depression and Anxiety scores indexed depressed and anxious mood. DASS = Depression Anxiety Stress Scales; DSHI = Deliberate Self-Harm Inventory; TMT-B = Trail Making Test Part B (a measure of set shifting, which is a form of executive functioning); SAP = Self-Aggression Paradigm (a measure of deliberate self-harm behavior).

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Table 1

Descriptive statistics and Cronbach's alphas for self-report scales.

	Minimum	Maximum	*M* (*SD*) or %	α
Age (years)	21	54	26.0 (7.6)	
Female (sex)			43.9	
Years of education	11	22	16.6 (2.0)	
Married			17.4	
WASI Full Scale IQ	83	138	111.4 (11.2)	
SNAP-2 Negative Temperament	0	28	9.9 (6.9)	.91
PCL-C	17	77	28.7 (11.4)	.92
DASS Depression	0	22	4.0 (4.6)	.91
DASS Anxiety	0	21	4.7 (4.0)	.80
DSHI	0	7	0.5 (1.4)	.82
SAP 20-Shock Frequency	0	20	3.4 (6.2)	
TMT-A (seconds)	15.67	61.52	29.8 (7.9)	
TMT-B (seconds)	32.5	205	60.6 (23.4)	

Note. N = 132; sample size for the SAP and TMT is 126 due to missing data. PCL-C = PTSD Civilian Checklist (proxy for life stress); SNAP-2 = Schedule for Nonadaptive and Adaptive Personality-2; DASS = Depression Anxiety Stress Scales; DSHI = Deliberate Self-Harm Inventory; TMT = Trail Making Test; SAP = Self-Aggression Paradigm (deliberate self-harm behavior).