



Research article

Are relationships between impulsivity and depressive symptoms in adolescents sex-dependent?



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ABSTRACT

Introduction: Both depressive symptomology and impulsivity are common during adolescence and are associated with various negative life outcomes. The potential sex-dependent nature of relationships between these constructs needs further exploration in order to understand their complexities. This cross-sectional study examined how levels of these constructs may differ by sex. Additionally, we investigated whether sex moderates relationships between adolescents' depression symptoms and different facets of impulsivity.

Methods: 156 adolescents ($M_{age} = 17.37$, $SD = 1.91$, 59% female) completed self-report measures of their demographics, depression symptoms, and impulsivity. Multiple Analysis of Covariance (MANCOVA) assessed mean differences in depression symptoms and impulsivity by sex and race/ethnicity. Moderation analyses examined how sex may indirectly affect relationships between depression symptoms to predict attentional, motor, and non-planning impulsivity facets, as well as overall trait impulsivity.

Results: Correlations between depression symptoms and impulsivity scores were significant. Baseline depression symptoms were significantly higher among females ($M = 9.53$) compared to males ($M = 6.68$). Moderation effects of sex were not significant for attentional, motor, or overall trait impulsivity. However, sex moderated relations between depression symptoms and non-planning impulsivity, such that adolescent males showed higher levels of non-planning impulsivity when they reported high levels of depressive symptoms ($B = .32$, $p < .01$). This relationship was not significant for females.

Conclusions: While adolescent females may be more prone to depression, adolescent males may be more likely to experience non-planning impulsivity when experiencing symptoms of depression. The results of this study extend the literature regarding sex differences in vulnerabilities between these constructs. We suggest interventions targeting non-planning impulsivity may be especially salient for adolescent males reporting high levels of depressive symptoms.

1. Introduction

1.1. Adolescent depression

Depression is the leading cause of ill health and disability in the world according to the World Health Organization (WHO, 2017. Accessed 2018) and symptoms are usually first detected during adolescence. In fact, Major Depressive Disorder (MDD) has been shown to have reported prevalence rates of approximately 4.6% among males and 5.9% among females between the ages of 13 and 18 (Jane Costello et al., 2006), making it one of the most prevalent adolescent psychiatric disorders (Curry et al., 2011). Additionally, MDD has been shown to have reported recurrence rates up to 75% (Fombonne et al., 2001). Major Depressive

Disorder is characterized by depressed mood, diminished interest, insomnia or hypersomnia, fatigue, feelings of worthlessness, indecisiveness and suicidal ideation (American Psychiatric Association [APA], 2013). While adolescent depression is often found to be comorbid with internalizing issues such as anxiety (Garber and Weersing, 2010), it is imperative further research be conducted in order to determine the influences that this disorder might have with externalizing issues in the lives of adolescents.

1.2. Impulsivity facets and their relationships with adolescent depression

Impulsivity, conceptualized as a relatively stable personality trait among some individuals, is a heavily studied construct. It has been

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thought to contribute, in part, to adolescents' depressive symptoms (Auerbach et al., 2017; Eisenberg et al., 2009). However, the precise nature of the relationship between trait impulsivity and depression among adolescents is unclear, given that impulsivity has different facets, which are theorized to reflect different underlying processes (Reynolds et al., 2006). Barratt's (1985) three facet model of impulsivity, consisting of Attentional, Motor, and Non-Planning Impulsivities, is highly influential and among the most widely researched (Stanford et al., 2009; Patton et al., 1995). Below, we briefly review these facets and their relationships with depressive symptoms.

1.3. Attentional Impulsivity

Attentional Impulsivity, defined as an inability to focus or concentrate (Stanford et al., 2009), is one facet of impulsivity believed to be affected by depressive symptoms. A recent meta-analysis suggested depression severity is negatively correlated with performance on several types of cognitive and behavioral tasks requiring attentional resources (McDermott and Ebmeier, 2009). Kyte et al. (2005) found those with first onset of MDD, compared to community controls, displayed attentional biases towards negative emotional stimuli, suggesting depressive symptoms may influence Attentional Impulsivity through dysfunctions in attention and concentration capacities. Additionally, adolescents' depression symptom severity and depressed mood have both been associated with poor sustained attention during cognitively demanding tasks (Cataldo et al., 2005). Together, these studies indicate a potential link between adolescents' depression severity and deficits in their ability to focus, concentrate, and pay attention.

1.4. Motor Impulsivity

Motor Impulsivity is a tendency towards acting without thinking (Barratt, 1985). One study suggested adolescents with high levels of Motor Impulsivity may be more likely to report depressive symptoms. Specifically, questions assessing an individual's ability to think before taking action when handling negative events (i.e. the Refocus on Planning subscale of the CERQ; Garnefski et al., 2001) mediated the relationship between impulsivity traits and depressive symptoms (d'Acremont and Van der Linden, 2007). Carver et al. (2013) examined impulsivity facets among individuals with MDD and discovered they had reflexive reactions towards emotions more often than controls. For depression-vulnerable adolescents, Motor Impulsivity may also contribute towards risk behaviors. Adolescents with low levels of positive affect (i.e. a symptom of depression) were more likely to report alcohol involvement when they displayed an inability to inhibit their motor responses on a behavioral impulsivity measure (Colder and Chassin, 1997), suggesting Motor Impulsivity may indirectly affect other externalizing behaviors for depression-vulnerable adolescents.

1.5. Non-planning impulsivity

Non-Planning Impulsivity has been described as a lack of "futuring" or forethought (Barratt, 1985; Stanford et al., 2009). Imhoff et al. (2014) found adolescents who indicated high preferences for immediate vs. delayed rewards (i.e. a conceptualization of Non-Planning Impulsivity termed *delay discounting*) were more likely to report depressive symptoms. Non-Planning Impulsivity may relate to depression via poor self-esteem and interpersonal problems; Non-Planning Impulsivity explained more variance in predicting these problems on a depression inventory administered to children, compared to Attentional and Motor facets (Cosi et al., 2011). Fradkin et al. (2017) administered the Barratt Impulsiveness Scale (BIS-11; Barratt, 1985) to adolescents diagnosed with MDD and matched controls and found, while those with MDD reported higher scores for all BIS Impulsivities, the facet with the largest mean difference between groups was Non-Planning Impulsivity. Thus, among adolescents, depressive symptomatology may influence impulsivity

via an inability to plan ahead.

1.6. Sex differences in depression and impulsivity

For adolescents, it is unclear whether potential relationships between depression symptoms and impulsivity depend on sex. While internalizing issues, such as anxiety and depression, are more common among adolescent females (Matos et al., 2017), externalizing issues, such as symptoms of Attention-Deficit/Hyperactivity Disorder (ADHD), Conduct Disorder, and substance abuse, are more common in males in younger populations (APA, 2013). This suggests adolescent males are more predisposed to think and/or act impulsively. In support of this view, Wittmann et al. (2008) found that adolescent males reported higher scores on the Attentional and Non-Planning subscales of the BIS-11 compared to females. Additionally, early-adolescent males display lower inhibitory control than age-matched females (Moilanen et al., 2009).

However, when predicting whether males or females are vulnerable to depression, research suggests females with high impulsiveness are at particular risk. One study indicated adolescent females diagnosed in early childhood with ADHD, a disorder characterized by several facets of impulsivity, were at greater risk for experiencing depression symptoms in adolescence compared to males (Chronis-Tuscano et al., 2010). Rudolph et al. (2013) found that adolescent females low in inhibitory control were more likely to exhibit depressive symptoms compared to males. Other research corroborates these findings and suggests relationships between impulsivity and depression are especially salient for females (i.e. Agoston and Rudolph, 2016; Quinn, 2005).

However, null findings regarding sex differences between these variables have also been reported. Wang et al. (2015) reported sex did not moderate the relationship between adolescents' depressive symptoms and effortful control, a facet of impulsivity conceptually similar to Motor and/or Non-Planning Impulsivity. Li and Chen (2007) also did not find significant sex differences on BIS-11 measures of impulsivity among adolescents. Thus, although some research points towards sex differences, it is unclear whether associations between particular aspects of impulsivity and depressive symptoms differ between male and female adolescents. As sex differences for depression are well documented, and peak largest during adolescence (Salk et al., 2017), more research is needed to inform theories of vulnerability regarding the role of sex within these constructs.

1.7. The current study

In order to examine the relationships between depressive symptoms and impulsivity, as well as examine potential differences for male and female adolescents, the goals of our study were two-fold. First, we sought to examine how baseline levels of depression symptoms and impulsivity may differ by sex. Therefore, based on prior research suggesting adolescent girls are more prone to depression when compared to boys (Matos et al., 2017; Salk et al., 2017), we hypothesized females in our study would report more depressive symptomatology overall. Second, we sought to test whether sex moderates relations between depression symptoms and different facets of impulsivity among an adolescent population. Therefore, in line with prior research suggesting relationships between depression and impulsivity are more salient for adolescent girls compared to boys (Agoston and Rudolph, 2016; Chronis-Tuscano et al., 2010; Rudolph et al., 2013), we hypothesized females in our study would report higher levels of all impulsivity facets when they also reported high levels of co-occurring depressive symptomatology.

2. Method

2.1. Participants

The data collected for the current study are taken from a larger project examining facets of impulsivity among adolescent obese and non-obese

smokers. Ethical approval was obtained from the Institutional Review Board at the study university. Participants consisted of adolescents recruited from surrounding counties via flyers posted in community areas, newspaper/social media advertisements, and undergraduate psychology courses. A total of 157 adolescents ranging from 13 to 20 years old ($M_{age} = 17.37, SD = 1.91, 60\%$ female) were examined for analysis. One participant was removed from analyses for missing data, resulting in a final sample size of 156. The majority of these participants identified as Caucasian (65.4%), while lesser amounts reported Hispanic/Latino (14.1%), Asian (7.1%), African-American (6.4%) and other (7.1%) ethnicities. All participants included in the present study received either: 1) \$25-\$35 in monetary compensation, specific amounts depending on behavioral task performance or 2) course credit for participation.

Potential participants were excluded from the study if they were not between the ages of 13–20 or reported taking ADHD medications at the time of screening. These exclusion criteria were deemed necessary because: 1) we sought to examine an adolescent population, stipulated by the Council on Child and Adolescent Health (1988) to include individuals up to age 21, and 2) medications used to manage ADHD have been shown to reduce impulsive behaviors as measured by the behavioral assessments included within the larger project (Tannock et al., 1989).

Participants and their parent or guardian reported to the Health Behavior Research Group at Texas A&M University, where they completed self-report paper and pencil measures of their demographics (including sex), depression symptoms, and impulsivity, administered among a larger battery of self-report assessments and behavioral tasks. Informed assent and parental consent were obtained by trained research assistants.

2.2. Measures

2.2.1. Beck Depression Inventory-II

Depressive symptomology was assessed using the Beck Depression Inventory-II (BDI; Beck, 1996). The BDI-II is a widely used 21-item self-report inventory used to assess cognitive, behavioral, and emotional impairments associated with severity of depression, with higher scores indicating greater levels of depression symptoms. The BDI-II has been shown to correlate well with other measures of adolescent depression symptoms and demonstrate adequate psychometric properties among non-clinical adolescent samples (coefficient $\alpha = .92$, inter-item correlation = .35; Osman et al., 2008). Cronbach's alpha for the present sample was .91.

2.2.2. Barratt Impulsiveness Scale-adolescent

The Barratt Impulsiveness Scale—Adolescent (BIS-11-A; Fossati et al., 2002) was used to assess impulsivity. The BIS-11-A is an adaptation of the adult BIS-11 (Patton et al., 1995) which measures general impulsiveness, taking into account the multi-factorial presentation of this construct. It contains three subscales measuring three different facets of impulsivity: 1) Attentional (i.e. an inability to concentrate), 2)

Non-Planning (i.e. lack of forethought), and 3) Motor (i.e. a tendency to act on the spur of the moment) Impulsivities, with higher scores indicating greater impulsivity. Cronbach's alpha for the BIS-11-A in the present sample was .79, with differential Cronbach's alphas for each of the three subscales: The Attentional subscale was .72, the Motor subscale was .52, and the Non-Planning subscale was .68.

While the internal consistency estimates for the overall BIS-11-A and its Attentional subscale were acceptable, the estimates for the Motor and Non-Planning subscales were more questionable. However, Hair et al. (2010) argue that Cronbach's alpha values as low as .60 are suitable for exploratory research. The low values are perhaps explained by our sample, which consisted largely of Caucasian adolescent smokers, as “low” Cronbach's alphas can, at times, be considered an artifact of homogenous samples (Bernardi, 1994). Nonetheless the low values do serve as a limitation of our analysis.

2.2.3. Data analytic plan

To examine whether baseline differences between depression symptoms and impulsivity differed by sex, a multiple analysis of covariance (MANCOVA) was conducted in the Statistical Package for the Social Sciences (SPSS), Version 23.0 (IBM Corp., 2015) to determine mean differences between the sexes on their BDI-II and BIS-11-A scores. Race/ethnicity was entered as a covariate in the MANCOVA and all subsequent analyses. Race/ethnicity was represented as a series of dummy-coded variables in which Caucasians served as the comparison category; this group was contrasted against Hispanic/Latino, Asian, African-American, and other ethnicities. To examine whether sex moderated relations between depression symptom scores and attentional, motor, and non-planning impulsivity facets, a series of multiple regression analyses were conducted using the PROCESS macro (Hayes, 2017) for SPSS. In these analyses, female (coded 0)/male (coded 1), BDI-II scores, and their interaction were entered as predictors of BIS-11-A scores (See Table 3), controlling for race/ethnicity. This moderation analysis was repeated four times in order to predict overall impulsivity, as well as attentional, motor, and non-planning impulsivity facets. Follow-up multiple regression models that excluded the interaction term were run to calculate main effects. A Bonferroni correction was applied ($0.05/4 = 0.013$) to control for multiple comparisons within these analyses.

3. Results

Correlations between sex, race/ethnicity, depression symptoms, impulsivity facets are presented in Table 1. As shown, correlations between BDI-II scores and BIS-11-A scores were significant for Overall Impulsivity ($r = .239, p < .01$), and the Attentional ($r = .275, p < .01$) subscale. The correlation for the Non-Planning subscale was initially significant, ($r = .161, p = .04$), but it did not pass the Bonferroni correction. BDI-II scores were not significantly correlated with the Motor subscale. These correlations verify some of the expected relationships

Table 1
Correlations between primary study variables.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Race/Ethnicity										
1. African-American		-.072	-.106	-.072	.055	.084	.040	.019	.016	.058
2. Asian			-.112	-.076	.083	.038	-.004	.012	.033	-.039
3. Hispanic/Latino				-.112	-.028	.168	.047	-.001	.097	.028
4. Other					.032	.126	.023	.068	-.072	.055
5. Sex						-.175	.118	.052	.142	.100
6. Depression Symptoms							.239*	.275*	.053	.161
7. Overall Impulsivity								.685*	.744*	.816*
8. Attentional									.342*	.351*
9. Motor										.405*
10. Non-Planning										

Note: * p-values passed a Bonferroni test for multiple comparisons ($p = .013$).

Table 2
Means (SDs) and group differences for impulsivity facets and depressive symptoms by sex and race/ethnicity.

	Total (n = 151)	Male (n = 61)	Female (n = 90)	<i>p</i>	Caucasian (n = 100)	African-American (n = 8)	<i>p</i>	Asian (n = 11)	<i>p</i>	Hispanic/Latino (n = 21)	<i>p</i>	Other (n = 11)	<i>p</i>
Depressive Symptoms	8.40 (8.17)	6.68 (5.88)	9.53 (9.24)	.03	6.90 (7.09)	11.25 (8.55)	.07	9.45 (9.31)	.21	11.76 (7.85)	.01	12.00 (10.94)	.03
Overall Impulsivity	62.68 (9.50)	64.10 (9.11)	61.73 (9.68)	.13	62.33 (9.80)	64.20 (9.08)	.93	62.64 (7.19)	.99	63.86 (10.39)	.36	63.55 (6.88)	.71
Attentional Impulsivity	16.14 (4.05)	16.43 (3.53)	15.94 (4.38)	.47	15.95 (4.39)	16.40 (4.24)	.99	16.27 (3.04)	.88	16.09 (3.32)	.77	17.09 (2.88)	.42
Motor Impulsivity	23.30 (3.81)	23.92 (3.60)	22.89 (3.90)	.10	23.20 (3.83)	23.60 (3.95)	.90	23.82 (3.49)	.68	24.27 (4.31)	.22	22.36 (3.14)	.47
Non-Planning Impulsivity	23.11 (4.53)	23.75 (4.72)	22.69 (4.37)	.16	23.00 (4.75)	24.20 (3.71)	.72	22.55 (3.93)	.71	23.50 (4.83)	.43	24.09 (3.91)	.44

Table 3
Moderation analyses between depressive symptoms and sex to predict impulsivity, controlling for race/ethnicity.

	BDI Effect			<i>p</i>	Sex Effect			<i>p</i>	BDI x Sex		<i>p</i>
	B(SE)	β	t (143)		B(SE)	β	t (143)		B(SE)	t (142)	
Overall	.32 (.10)	.27	3.22	<.01	3.39 (1.60)	.18	2.13	.04	.49 (.23)	2.12	.04
Attentional	.15 (.04)	.30	3.60	<.01	.96 (.68)	.12	1.41	.16	.08 (.10)	.77	.44
Motor	.04 (.04)	.07	.85	.39	1.16 (.66)	.15	1.76	.08	.17 (.10)	1.81	.07
Non-Planning	.10 (.05)	.18	2.08	.04	1.37 (.78)	.15	1.77	.08	.28 (.11)	2.57	.01

Note: **Bolded** *p*-values indicate those which passed a Bonferroni test for multiple comparisons ($p = .013$).

between depression symptoms and impulsivity within the current population. Identifying as female (dummy-coded 0; $r = -.175, p = .03$) or Hispanic/Latino ($r = .168, p = .04$) was also correlated with BDI-II scores, but these correlations also did not pass the Bonferroni correction.

Mean differences between the sexes on depression symptoms and impulsivity were examined with multiple analysis of covariance (MANCOVA; See Table 2), with race/ethnicity variables included as covariates. Results indicated a main effect of sex ($F [1, 149] = 4.81, p = .03$), such that adolescent females reported significantly more depression symptoms ($M = 9.53, SD = 9.24$) than adolescent males ($M = 6.68, SD = 5.88$). Race/ethnicity emerged as a significant co-variate for depression symptoms as well, with adolescents identifying as Hispanic/Latino ($M = 11.76, SD = 7.85, F [1,149] = 6.71, p = .01$) or the Other ($M = 12.00, SD = 10.94, F [1,149] = 4.62, p = .03$) racial/ethnic group categories reporting significantly more depression symptoms compared to those identifying as Caucasian ($M = 6.90, SD = 7.09$). There were no

significant effects for sex, nor race/ethnicity, on impulsivity.

Results of the regression analyses are depicted in Table 3. As shown for Overall Impulsivity, the interaction term was initially significant ($B = .49, se(B) = .23, t (142) = 2.12, p = .04$), but it did not pass the Bonferroni correction. However, the main effect of depression symptoms was significant ($B = .32, se(B) = .10, t (143) = 3.22, p < .01$). For Motor Impulsivity neither the main effects of depression symptoms nor sex was significant. However, for Attentional Impulsivity, the main effect of depression symptoms was also significant, such that higher scores on the BDI-II predicted higher Attentional Impulsivity subscale scores on the BIS-11-A ($B = .15, se(B) = .04, t (143) = 3.60, p < .01$). However, neither the effect of sex nor the interaction between sex and depression symptoms were significant. Race/ethnicity was not a significant covariate in any of the aforementioned models.

For Non-Planning Impulsivity, however, the interaction was significant (see Fig. 1). Sex moderated the relationship between depression

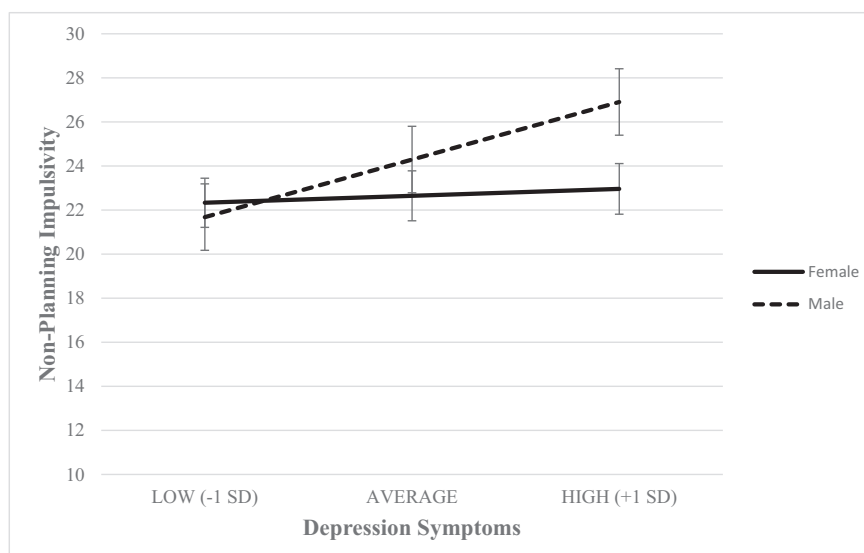


Fig. 1. Interactive effect of sex on the relationship between depression and non-planning impulsivity.

symptoms and Non-Planning Impulsivity ($B = .28, se(B) = .11, t(142) = 2.57, p = .01$) in that, as depression symptoms increased, males were more likely than females to report high levels of Non-Planning Impulsivity. Simple slope analysis shows that among adolescent females Non-Planning Impulsivity was low and there was no significant relation between depression symptoms and Non-Planning Impulsivity, whereas among adolescent males Non-Planning Impulsivity was generally higher and there was a significant positive relationship between depression symptoms and Non-Planning Impulsivity ($B = .32, se(B) = .10, t(142) = 3.19, p < .01$). Race/ethnicity was not a significant covariate in this model.

4. Discussion

The aim of this study was to examine how baseline levels of depression symptoms and impulsivity may differ by sex and to test whether sex moderates relations between depression symptoms and different facets of impulsivity among an adolescent population. The three facets of impulsivity examined in this study included: Attentional, Motor, and Non-Planning Impulsivities. Because depression symptoms and impulsivity have been associated with various negative life outcomes during adolescence, it is important that we begin to understand the complexity surrounding these relationships and how they may present differently between adolescent males and females.

Correlations between depression symptoms and impulsivity facets were significant and positive in our study. This finding corroborates earlier research (Auerbach et al., 2017; Eisenberg et al., 2009; Smith et al., 2013). However, predictive relationships differed between facets of impulsivity. For example, our only observed main effect was between the BDI-II and Attentional Impulsivity subscale, suggesting adolescents reporting more symptoms of depression may concurrently report difficulties in attention and/or concentration. Our null findings regarding the Motor subscale perhaps suggest this relationship may reveal itself in clinical samples, rather than community ones. For instance, Fradkin et al. (2017) did report higher BIS-11 Motor subscale scores in adolescents with a DSM-IV primary diagnosis of MDD and a history of suicide attempt compared to controls.

This study did not find significant differences in baseline impulsivity between males and females, supporting prior research (Li and Chen, 2007). Also, although not hypothesized, we did discover that Hispanic/Latino and adolescents who identified as an "Other" category of race/ethnicity reported more depression symptoms when compared to Caucasians. This aligns with research suggesting minority adolescents tend to have higher rates of depression than White adolescents (Centers for Disease Control [CDC], 2018; Moon and Rao, 2010) and calls attention to the need for targeted depression intervention for minority youth. Self-identified Hispanic adolescents, and/or adolescents not identifying as a particular racial category (e.g. ethno-racially mixed youth) may be at particular risk.

However, in regards to our first hypothesis, the first key finding of our study was that baseline levels of depression symptoms were higher among adolescent females compared to males. This verified sex differences found in previously conducted studies (Matos et al., 2017; Salk et al., 2017; Van Droogenbroeck et al., 2018) and supported our hypothesis. These findings imply that adolescent females may be more prone to report depression symptoms compared to adolescent males.

However, it is possible that adolescent males experience depression symptoms differently than females, and concurrently exhibit more Non-Planning Impulsivity. In the second key finding of our study, as males reported more depression symptoms, they reported more traits of the Non-Planning Impulsivity facet. This relationship was not statistically significant for females, suggesting the relationship between depression and Non-Planning Impulsivity is salient for males. We did find an interaction between depressive symptoms and sex on Overall Impulsivity, with the positive relationship between these constructs higher for males; however, this did not pass a Bonferroni correction. Therefore, we regard

this finding as exploratory. These findings contrasted relationships reported in prior studies, which suggest the relationship between depression and impulsivity is stronger for females (Agoston and Rudolph, 2016; Chronis-Tuscano et al., 2010; Rudolph et al., 2013), and did not support our second hypothesis.

These findings are perhaps explained by the large presence of tobacco smokers in our sample. Adolescent male smokers have been shown to report higher impulsivity (Fields et al., 2009) and more depression symptoms (Escobedo et al., 1998) when compared to female smokers and both male and female non-smokers. Thus, the presence of cigarette smokers in our sample may have influenced our reported relationships. More generally, Wang et al. (2016) found that higher trait impulsivity predicted co-occurring internalizing (e.g. depression) and externalizing (e.g. aggression, rule-breaking, etc.) problem behaviors in adolescent males, but not females. This finding, in combination with our own findings, suggest more research is needed to determine whether adolescent males are at-risk for impulsive behavior when concurrently reporting depressive symptoms, or vice-versa, and how cigarette use may influence this relationship.

Perhaps this begins to explain some of the vulnerability in these constructs for males. Externalizing behaviors are typically more common among adolescent males compared to females (APA, 2013) and both are comorbid with and may contribute towards later experiences with MDD (McDonough-Caplan et al., 2018). Perhaps Non-Planning Impulsivity has a particular role in this relationship for adolescent males. Peters et al. (2012) found that co-occurring young adults' externalizing behavior (i.e. poly-substance abuse) was significantly and particularly associated with Non-Planning Impulsivity, compared to other facets. As their sample was largely (70%) male, the Non-Planning Impulsivity facet may particularly influence externalizing behaviors for adolescent males, like cigarette or other substance use. This vulnerability may become exacerbated when males experience depression, or, vice-versa, Non-Planning Impulsivity may put males at risk for future experiences with MDD. Future research should further examine the potential sex-dependent nature of relationships between impulsivity, especially the Non-Planning facet, and associations with depression.

Sex was not shown to moderate the relationship between depression symptoms and Motor or Attentional Impulsivity facets. Therefore, differential vulnerabilities may not exist between sexes for these facets, may not be salient for adolescents reporting depression symptoms, or may reveal themselves in clinical rather than community populations. Although originally not hypothesized, our study did show a main effect on depression symptoms for Attentional Impulsivity. More research is needed in order to determine the precise nature of these relationships among adolescents and if, indeed, particular facets of impulsivity are impacted by emotional states like depression differentially among males and females.

4.1. Limitations

The findings of this study should be interpreted in light of its limitations. Our sample was moderately homogeneous, as the majority of participants identified as Caucasian (65.4%). Further research should be conducted using a more ethnically diverse sample of adolescents. Also, although the sample used for the study were aged 13–20 years old, the average age was 17.37 years. These findings may or may not replicate in a younger adolescent population, or our findings and resulting conclusions may only apply to older adolescents. Third, the BIS-11-A's Motor and Non-Planning subscales Cronbach's alpha estimates were low. Therefore, it may be appropriate for future research to use a scale with higher internal consistency estimates for its subscales. Fourth, our sample for analysis contained more females ($n = 90$) than male ($n = 60$) participants. Future research should examine sex differences with balanced numbers of males and females. Additionally, potential participants were excluded from the larger study if they reported ADHD medication use at the time of screening. Although this was deemed necessary exclusion

criteria to control for behavioral assessment performance (Tannock et al., 1989), the use of other psychotropic medications can affect impulsivity symptoms (Links et al., 1990; Lee et al., 2015). Therefore, it may be appropriate for use of any psychotropic medication at the time of screening to serve as an exclusion criterion for future research. Last, our sample included adolescent cigarette smokers, who may differ in important ways from their non-smoking counterparts. Our findings may, therefore, may or may not replicate among adolescent non-smokers.

5. Conclusions

The results of our study extend theory regarding sex differences in impulsivity and/or depression vulnerability within adolescents. The main findings of this research suggest that: 1) adolescent females may be more prone to experience depression symptoms than males, and 2) adolescent males may be more likely to report Non-Planning Impulsivity when concurrently reporting depression symptoms. We suggest that adolescent males reporting depression symptoms be screened for their levels of impulsivity, as intervention targeting Non-Planning Impulsivity may be particularly salient for adolescent males. Further research conducted with larger, more diverse samples of adolescents (e.g. in terms of ethnicity, age, smoking status, etc.) will further inform theories of internalizing vs. externalizing vulnerability for adolescents, which are likely at least partially influenced by sex.

Declarations

Author contribution statement

Timothy Regan, Bethany Harris: Analyzed and interpreted the data; Wrote the paper.

Sherece A. Fields: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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