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An experimental paradigm examining the influence of frustration on risk-taking behavior

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ABSTRACT

The present study examined the impact of frustration on risk-taking in college students with low and high ADHD symptomatology (L-ADHD and H-ADHD). Participants completed the Balloon Analogue Risk Task (BART) following induced frustration from a mood manipulation task (experimental session) and following no mood manipulation (control session). A manipulation check revealed a significant three-way interaction where the H-ADHD group reported higher frustration levels compared to the L-ADHD group, particularly in response to the frustration induction in the experimental condition. Primary results revealed that the L-ADHD group exploded significantly fewer balloons in the experimental condition compared to the control condition; there was a nonsignificant difference of balloon explosions across conditions for the H-ADHD group. The study provides initial laboratory-based support for the impact of frustration on the risk behavior of those with low and high levels of ADHD, with potential implications for future studies and ultimately for intervention.

1. Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by a pervasive pattern of inattention, hyperactivity, and/or impulsivity that interferes with functioning and development (DSM-5, American Psychiatric Association [APA], 2013). One key problem behavior associated with ADHD is risk-taking (Kroyzer et al., 2014). Evidence suggests that children and young adolescents with ADHD are generally more impulsive (Wilson et al., 2011; Winstanley et al., 2006). Thus, these children engage in more risk-taking behavior than their counterparts without the disorder (Kroyzer et al., 2014), and they also evidence continued risk-taking behavior throughout older adolescence and into adulthood. Throughout development, risk-taking behaviors become increasingly dangerous and can include alcohol and substance misuse (Ohlmeier et al., 2008), risky driving (Richards et al., 2006; Thompson et al., 2007), problem gambling (Breyer et al., 2009), and sexual behavior (Flory et al., 2006).

Being in a negative emotional state can impact risk-taking behavior (Çetin et al., 2014; Deffenbacher et al., 2001), and this may be particularly true for young individuals with ADHD (Oliver et al., 2011). One emotional state that can serve as a risk factor for engaging in risky behavior is frustration, which is a subjective feeling of unpleasantness associated with high levels of anticipated extreme effort that an individual may experience from failing to achieve a desired goal (Deveney et al., 2013; Perlman et al., 2014; Smith and Ellsworth, 1985; Yu et al., 2014). Frustration has been induced in a controlled experimental setting in children with and without ADHD through a variety of mood induction tasks (e.g., Maedgen and Carlson, 2000; Melnick and Hinshaw, 2000; Scime and Norvilitis, 2006; Walcott and Landau, 2004), with results showing that individuals with ADHD become frustrated more easily than those without the disorder. In one particular study, Scime and Norvilitis (2006) examined task performance on an arithmetic task of increasing difficulty and a challenging puzzle task in children ranging in age from 6 to 12 years old with and without ADHD. Results indicated that children with ADHD became more frustrated than the comparison children, both in general and when completing the tasks designed to elicit frustration. Children with ADHD also engaged in less mood repair, which is a factor of emotional competence (Rockhill

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and Greener, 1999; Salovey et al., 1995) characterized as an individual's perceived ability to regulate his or her own emotions (Scime and Norvilitis, 2006).

Compared to the vast literature examining negative emotion in children with ADHD, less research has investigated the relationship of the response in negative emotions in college-aged young adults with ADHD (Glutting et al., 2005; Weyandt and DuPaul, 2006), possibly due to ADHD's status as a neurodevelopmental disorder, with symptom onset occurring before the age of 12 (DSM-5, APA, 2013). However, though symptom presentation may begin to differ as individuals progress through development, the majority of children and early adolescents with ADHD continue to display ADHD symptoms into adulthood (Weyandt and DuPaul, 2006). More research is needed to examine college students with ADHD symptoms because they are at greater risk for academic and psychological difficulties (Weyandt and DuPaul, 2008). Additionally, previous research has demonstrated that problematic substance use peaks in the early 20 s (Littlefield et al., 2009), and students with ADHD are more likely to use tobacco, marijuana, and non-marijuana illicit substances and experience alcohol-related problems (Rooney et al., 2011) and alcohol-use disorders (Rooney et al., 2012) compared to students without the disorder.

Of the past studies which have explored frustration and its role in risk-taking in ADHD among young adults, only one study, to our knowledge, used a controlled laboratory paradigm (as opposed to relying solely on naturalistic assessment). Oliver and colleagues (2011) utilized a driving task and examined the role of frustration measured subjectively (through self-report) and objectively (through cardiorespiratory physiological measures) on driving behavior in 42 young adults with high (five men and 15 women) versus low (five men and 17 women) ADHD symptoms. Participants with high ADHD symptoms experienced significantly higher levels of frustration compared to individuals with low ADHD symptoms in both the baseline driving condition and the frustration driving condition. While this work provides an important starting point, there is a need for further research which directly explores the impact of frustration on risk-taking for young adults with elevated levels of ADHD.

The aim of the present study was to examine the impact of a frustration intervention on risk-taking behavior in young adults with and without elevated ADHD symptoms. We used the Balloon Analogue Risk Task (BART; Lejuez et al., 2002), a laboratory task which models risk-taking where behavior is rewarded (participants earn money by pumping a virtual balloon) until a certain point; continued risk-taking results in a negative consequence (after an unknown amount of pumps, the balloon will explode, and money earned from that balloon is lost). Previous research has shown that risk-taking on the BART is positively correlated with self-reported risk-taking behavior, such as alcohol and drug use, smoking, gambling, aggression, and unprotected sex (Lauriola et al., 2014; Lejuez et al., 2002; Lejuez et al., 2003a, 2003b). Additionally, "at-risk" groups, such as smokers (Lejuez et al., 2005) and substance users (e.g., Bornovalova et al., 2005; Crowley et al., 2006), often display differences in behavior on the BART in comparison to control groups (Lauriola et al., 2014). We hypothesized that two groups, a high versus low ADHD-symptom group, would differ on self-reported frustration and on risk-taking behavior in the experimental frustration condition to a greater degree than in a control condition. In other words, compared to the low ADHD-symptom group, the high ADHD-symptom group would self-report higher levels of frustration in both conditions, as well as engage in more risk-taking behavior as measured by the BART, particularly when frustrated. Additionally, the difference of frustration and risk-taking behavior would be more pronounced in the experimental condition compared to the control condition.

2. Method

2.1. Participants

Participants included 41 current college students recruited from a public university through flyers posted throughout the campus, within a one-mile radius around the campus, and electronically (e.g., campus web postings). To participate in the study, interested individuals had to be: a) between 18 and 25 years old; b) currently enrolled as a university undergraduate student; c) live away from parents either on- or off-campus, which has been used extensively in the ADHD literature to index independency in terms of self-regulating emotion (Rooney et al., 2011, 2012); and d) be willing to complete both sessions of the study. Students interested in participating in the study contacted the researchers, who replied with the screener (developed on Qualtrics.com) to determine eligibility.

Two-hundred eight individuals completed the screener. Of these participants, 81 met inclusion criteria and were invited to participate in the study. The 127 individuals who were not eligible to participate in the study were not current undergraduate students (e.g., they were recent graduates of the university) or were living with their parents at the time of study recruitment. Forty individuals were excluded from the analyses because their total ADHD *T*-scores on the Conners' Adult ADHD Rating Scales Self-Report Screening Version (CAARS-S:SV; Conners et al., 1999) did not fit with either "low" or "high" ADHD symptomatology; in other words, their scores fell between the "Average" to "Above average" range. Consistent with our extreme groups design, we included participants whose total CAARS-S:SV *T*-scores were 50 and below ("Average" to "Much below average"; Conners et al., 1999) and those with a total ADHD *T*-score of 65 and above (classified as having clinical elevations of ADHD symptoms—"-Much above average" and "Very much above average"). The final sample included 41 participants (43.9% male) with a mean age of 19.80 (SD = 1.29); 53.7% self-identified as being white/Caucasian, 9.8% as black/African-American, 17.1% as Asian-American, and 7.3% as Latino/-a, and 12.2% as other or of mixed ethnicities. This resulted in 20 L-ADHD (48.8%, range of total *T*-scores = 34 to 50, M = 45.81, SD = 4.81) and 21 H-ADHD (51.2%, range of total *T*-scores = 66 to 90, M = 77.25, SD = 7.83) participants.

2.2. Procedures

Procedures followed a two-by-two counterbalanced experimental design, with one between-subject factor (ADHD group: L-ADHD versus H-ADHD symptoms) and one within-subject factor (condition: control and experimental). All study procedures were approved by the university's Institutional Review Board (IRB). Participants visited the laboratory to complete both sessions, which were separated by one week (i.e., seven days). Each session included procedures for one of the two conditions, control or experimental. The order of the conditions was counterbalanced across participants, with half of both groups randomly receiving the control condition first and the other half of both groups receiving the experimental first. Undergraduate and post-baccalaureate research assistants running the participants were blind to participant ADHD status.

In the first session, all participants completed informed consent procedures administered by a research assistant. We then collected demographic information and measured baseline emotions with the "pre"-Positive Affect/Negative Affect Scale, which we referred to as Pre-PANAS (PANAS; Watson et al., 1988) and ADHD symptomatology utilizing the CAARS-S:SV. After completing the self-report measures, frustration was either induced or not induced, depending on whether participants were completing the experimental or control condition. Participants then completed the PANAS for a second time (Post-PANAS) and completed the BART. Session two followed procedures identical to session one, except that participants completed the condition (experimental, control) that they did not complete at session one.

Research assistants debriefed participants at the end of session two. Participants were compensated after both sessions based on their earnings from the BART, which ranged from $2.00 to $10.00. Participants were awarded with a bonus of $10.00 at the end of their second session if they attended and completed both appointments, resulting in a maximum total earning of $30.00.

2.3. Frustration induction

Frustration was induced only in the experimental session. The frustration induction started after the research assistant collected the first set of questionnaires (e.g., Pre-PANAS, ADHD history, etc). A common way to induce anger or frustration in a laboratory setting is through the use of scripts and deceptions (e.g., Leith and Baumeister, 1996; Lobbestael et al., 2008). As a novel way of inducing frustration in a way that mimicked a natural setting, the research assistant deceived participants into believing that s/he misplaced the laptop needed for the study task, and s/he had participants sit alone in the participant room without any distractions for 15 min. Fifteen minutes was chosen as the duration for the mood induction because it was a long enough time for participants to become frustrated, but short enough for participants not to become angry and leave the session before completing the BART. At five-minute intervals (i.e., five minutes and ten minutes into the frustration induction), the research assistant checked in with the participant to notify them of the status of the equipment, as well as to make sure that participants were not asleep, had not become too angry during this time, and had not found a way to distract themselves. If a participant questioned the wait period, the research assistant informed him/her that there was a malfunction with the task/laptop and that they were waiting for the programmer/computer technician to check the problem.

2.4. Measures

2.4.1. Positive and negative affect schedule (PANAS; Watson et al., 1988)

The PANAS is a 20-item self-report scale that assesses positive (e.g., “enthusiastic” and “attentive”) and negative (e.g., “upset” and “irritable”) emotions. Participants indicate on a scale of 0 (“*Not at all*”) to 10 (“*Extremely*”) the extent to which they are feeling the emotion indicated. Because our mood induction aimed to induce frustration, we utilized a slightly modified version of the original PANAS scale. “Frustrated,” our main emotion variable of interest, replaced “afraid” because “scared” was already included in the measure, and we had no purpose for having two separate items related to fear. “Ashamed” was replaced with “embarrassed,” a less intense adjective for feeling regret, and “mad” replaced “guilty,” as it has a closer relation to our main variable of interest (frustration). A modification of the PANAS has been done in several other published studies (e.g., Amstadter et al., 2012; Reynolds et al., 2013). The PANAS shows good reliability, and Cronbach’s α in our sample was high (session one: Pre-PANAS: $\alpha = 0.90$ for positive and 0.89 for negative items; Post-PANAS: $\alpha = 0.93$ for positive and 0.88 for negative items; session two: Pre-PANAS: $\alpha = 0.93$ for positive and 0.92 for negative items; Post-PANAS: $\alpha = 0.94$ for positive and 0.92 for negative items).

Previous studies have used the PANAS before and after mood inductions to assess affect change (e.g., Dowd et al., 2010; Gratz et al., 2013; Randall and Cox, 2001). Accordingly, we administered the PANAS after informed consent procedures at the beginning of the appointment (Pre-PANAS) and again immediately before completion of the BART (Post-PANAS). Pre- and Post-PANAS items were randomized.

2.4.2. Conners' adult ADHD rating scales self-report screening version (CAARS-S:SV; Conners et al., 1999)

The CAARS-S:SV is a 30-item self-report measure that assesses DSM-IV symptoms of attention-deficit/hyperactivity disorder (ADHD) in adults (Conners et al., 1999). This self-report screening version of the CAARS measures the core symptoms of ADHD (Conners et al., 1999).

The CAARS-S:SV is comprised of four subscales: 1) DSM-IV inattentive symptoms (nine items); 2) DSM-IV hyperactive-impulsive symptoms (nine items); 3) DSM-IV total ADHD symptoms (summed inattentive and hyperactive-impulsive symptoms); and 4) ADHD index (12 items). Respondents are asked to rate the how much at item applies to them on a four-point Likert scale (0 = “Not at all, never”; 1 = “Just a little, once in a while”; 2 = “Pretty much, often”; and 3 = “Very much, very frequently”). Sample items include, “I have trouble keeping my attention focused when working,” “I fidget (with my hands or feet) or squirm in my seat,” and “I am distracted when things are going on around me.” Raw scores are calculated by adding up all the items in each subscale, which are then converted to *T*-scores. The *T*-score is a standard score with a mean of 50 and a standard deviation of 10. Separate norms are provided for men and women in different age intervals (Conners et al., 1999).

Extreme groups for the present study were determined based on the total ADHD symptoms scale because it included the core symptoms of ADHD (e.g., Kumar et al., 2011; Steer et al., 2003). Due to our college-aged sample, we only focused on the 18 to 29-year-old interval of the measure. Internal consistency for the CAARS-S:SV in our sample was high ($\alpha = 0.95$).

2.4.3. ADHD history

The following four questions were asked in order to assess if participants had a previous history of ADHD diagnosis and/or a history of taking ADHD medication: 1) *Have you ever been diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD)?* 2) *Have you ever been prescribed medication for ADHD?* 3) *Do you currently take medication for ADHD?* 4) *Did you take your medication for ADHD today?* These questions were asked to determine if any participants had a previous diagnosis of ADHD, as well as if any participants had taken medication for ADHD. Because stimulant drugs decrease impulsive behavior and risk-taking in individuals with ADHD (White et al., 2007), we wanted to ensure that these medications would not interfere with study results. To eliminate ADHD medication as a potential confound, we asked participants not to take their ADHD medication on the days of their appointments. Participants reported that they did not take any ADHD medication on the days of their appointments, specifically on the day of their experimental session; only one participant in the H-ADHD group reported that she took her medication on the day of her control session.

2.4.4. Balloon Analogue Risk Task–auto pump (BART-AP)

The original BART (Lejuez et al., 2002) is a computer task that simulates real-world risk-taking behavior in the laboratory and has been used with both adolescents (e.g., Lejuez et al., 2003a, 2003b) and adults (e.g., Lejuez et al., 2002; White et al., 2008) with good test-retest reliability ($r = +0.77$; White et al., 2008). On the BART, risk-taking behavior is rewarded until a point, and further risk-taking results in a negative consequence. For the current study, a modified version of the BART, called the BART-AP, was utilized. On the BART-AP, participants are given the following instructions:

There will be 30 balloons, one at a time, on the screen. For each balloon, you enter the number of pumps you want to have the computer pump up the balloon in a box located below the balloon.

BUT remember, balloons explode if you pump them up too much. The explosion point varies across balloons, ranging from the first pump to the 128th pump. The ideal number of pumps is 64. What that means, is that if you were to make the same number of pumps on every balloon, your best strategy would be 64 pumps for every balloon. This strategy would give you the most money over a long period of time. However, the actual number of pumps for any particular balloon will vary, so the best overall strategy may not be the best strategy for any one balloon.

You earn MONEY for every pump. Each pump earns 1 cent. But if a balloon explodes, you lose the money you earned on that balloon. To

Table 1
Descriptive Statistics between Groups.

Variable	Total sample (N = 41)	L-ADHD (n = 21)	H-ADHD (n = 20)	t	p	d
Gender (% Male)	43.9%	28.6%	60.0%	$t(39) = -2.08$	.044	0.642
Age ($M(SD)$)	19.80 (1.29)	19.90 (1.04)	19.70 (1.53)	$t(39) = 0.50$	.617	0.154
Race (% Caucasian)	53.7%	28.6%	80.0%	$t(39) = 3.76$	.001	0.786
CAARS-S:SV T-score Total ($M(SD)$)	61.15 (17.14)	45.81 (4.81)	77.25 (7.83)	$t(31.277) = -15.40$	.000	4.865

keep the money for a balloon, stop pumping before it explodes and click on the box labeled "Collect $$$."

After each $$$ collection or explosion, a new balloon will appear.

As the above directions indicate, the task is comprised of thirty individually presented blue balloons where participants are able to type in the number of pumps they would like the program to pump up the balloon. Consistent with the original BART, pumps ranged from a minimum of 0 pumps to a maximum of 128 pumps, with the number of pumps corresponding to the monetary amount (in cents) that they can earn; each pump corresponds to a one-cent ($0.01) earning, as well as a balloon inflation of one degree (approximately 0.125 in. or 0.3 cm in all directions; Lejuez et al., 2002). Money is stored in the participants' temporary winnings. The participant can stop inflating the balloon at any time during each trial and then click on the "Collect $$$" button to save these temporary earnings to the permanent bank. The next balloon is then presented. Earnings cannot be removed from the permanent bank. Each balloon has an explosion point, which varies per balloon, and participants are not told when balloons will pop. If a balloon pops before the participant transfers temporary winnings into the permanent bank, all earnings for the balloon are lost, and then participants are presented with the next balloon.

Previous research compared the outcomes (e.g., adjusted score, unadjusted score, and target score, as well as the number of exploded balloons) between the BART and BART-AP. Results indicated that the BART and BART-AP were positively moderately correlated ($r = 0.62$, $p < .01$), and there were no differences between both behavioral measures (Pleskac et al., 2008). The main difference between the original BART and the BART-AP is that the latter task, utilized in the present study, allows participants to enter the number of pumps in advance that they want to pump the balloon (e.g., MacPherson et al., 2012). We utilized the BART-AP because individuals with ADHD, or more ADHD symptoms, could become more easily distracted than those without ADHD (or less ADHD symptoms); thus, this group would be less able to perform on the original BART. Furthermore, in past studies that utilized the original manual BART, participants, both real-world risk takers and those who are risk aversive, rarely exhibited risk-taking behavior (Pleskac et al., 2008). In other words, participants pumped each balloon well under 64 pumps, thus not maximizing their expected earnings. Additionally, risk-taking on the BART has been confounded with earning more money compared to non-risk-taking behavior (i.e., pumping each balloon well under 64 pumps). Because the aim of this study was to examine the impact of frustration on risk-taking behavior, risk-taking may be confounded with optimizing performance (i.e., earning more money). Thus, the BART-AP was a stronger measure of risk-taking behavior than the BART for the current study, as participants were told that the most optimal strategy overall (i.e., not for one particular balloon) was to indicate 64 "pumps" on each trial, and event feedback was provided for each trial.

2.5. Data analytic plan

Preliminary analyses included examining any significant differences in demographic variables between the two groups and their relations to the self-reported frustration and BART performance, as well as conducting a manipulation check to examine the impact of our frustration induction on affect state. Between-group differences were examined using independent sample *t*-tests. The manipulation check utilized a mixed between-within repeated measures analysis of variance (ANOVA), with ADHD symptomatology grouping (i.e., group) as the between-subjects factor and condition (control and experimental) and induction-time (pre-induction and post-induction) as the within-subject factors.

Primary analyses focused on the outcome variable of BART balloon explosions, which is how we measured performance on the BART. As has been done in other studies (e.g., Reynolds et al., 2013), we utilized explosions as the primary dependent variable to index the negative consequences of risk-taking behavior compared to the positive rewards (e.g., adjusted average pumps). A second repeated measures ANOVA with group as the between-subjects factor and condition as the within-subjects factor was conducted.

3. Results

3.1. Preliminary analyses

Independent sample *t*-tests were conducted to examine between group demographic differences: gender, age, and race (Caucasian versus non-Caucasian). Results indicated that there were significant differences across groups on gender and on race ($p = .044$, $d = 0.642$ and $p = .001$, $d = 0.786$, respectively; see Table 1). Specifically, there were more males and more Caucasian participants in the H-ADHD group than in the L-ADHD group. Data from the National Health Interview Survey, 1998–2009 (Akinbami et al., 2011) and other research (Kessler et al., 2006) indicate a similar pattern for gender, such that males are more likely to have ADHD than females. Regarding previous research which has examined rates of ADHD across different racial groups, one longitudinal study found that non-Hispanic Caucasian children had a higher prevalence of ADHD compared to all other racial groups early in data collection, but in later years, ADHD prevalence was similar across non-Hispanic Caucasian, non-Hispanic African-American, and Puerto Rican children (Akinbami et al., 2011).

While there were significant group differences in demographic variables, no demographic variable was related to any of the dependent variables, including the level of frustration as reported on the PANAS and our primary dependent variable of BART explosions in both the control and experimental conditions (see Table 2). Given that the utility of a covariate is determined by the relationship with the dependent variable(s), none were included as covariates in the final analyses. However, given potential concerns regarding the strong relationship in the literature between gender and ADHD, we re-conducted these analyses controlling for gender and found no change in any of the significant results.

3.2. Manipulation check

The effect of the mood manipulation in both conditions was examined using a mixed-analysis repeated measures analysis of variance (ANOVA), with two within-subject factors (condition: control condition and experimental condition; induction-time: pre-induction and post-induction) and one between-subject factor (group: H- versus L-ADHD). Results from examining the frustration item of the PANAS revealed a significant main effect of group ($F(1, 39) = 9.14$, $p = .004$,

Table 2
Correlations among Gender and Race Variables with Outcome Variables of Pre- and Post-Frustration Induction and BART Balloon Explosions.

Condition	Variable	Total sample (N = 41)		L-ADHD (n = 21)		H-ADHD (n = 20)	
		Gender	Race	Gender	Race	Gender	Race
Control	Pre-induction	0.09	−0.14	−0.06	0.00	−0.02	0.13
	Post-induction	0.04	−0.18	0.12	0.21	−0.24	−0.28
	BART explosions	0.18	0.02	0.30	0.19	0.04	−0.14
Experimental	Pre-induction	−0.21	−0.09	−0.20	−0.26	−0.37	0.31
	Post-induction	−0.07	−0.21	−0.09	−0.20	−0.31	0.17
	BART explosions	0.18	−0.15	0.11	0.16	0.06	−0.09

Note. All the correlations of gender and race with the pre- and post-induction and BART explosion variables were not statistically significant (i.e., $p > .05$).

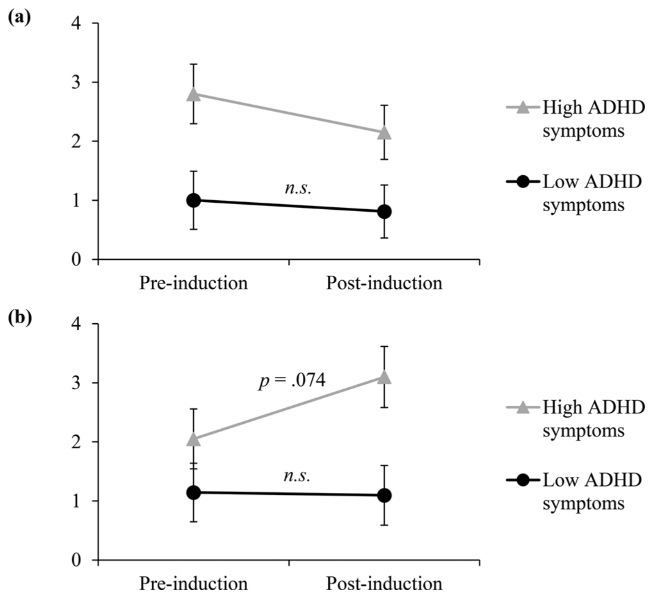

Fig. 1. Self-reported frustration levels as a function of ADHD group at pre- and post-frustration induction in the (a) control condition and (b) experimental condition.

Table 3
Means and Standard Deviations of Pre- and Post-Frustration Induction and BART Balloon Explosions in Both the Control and Experimental Condition.

Condition	Variable	L-ADHD (n = 21)		H-ADHD (n = 20)	
		M	SD	M	SD
Control	Pre-induction	1.00	1.76	2.80	2.69
	Post-induction	0.81	1.97	2.15	2.13
	BART explosions	14.38	2.42	14.60	2.26
Experimental	Pre-induction	1.14	2.13	2.05	2.42
	Post-induction	1.10	1.84	3.10	2.73
	BART explosions	13.33	2.01	14.95	2.69

$\eta_p^2 = 0.190$); main effects of condition and induction-time were not significant. Additionally, there was a significant three-way interaction for condition by induction-time by group ($F(1, 39) = 5.95$, $p = .019$, $\eta_p^2 = 0.132$), which suggested that the relationship between condition (control and experimental) and induction-time (pre- and post-frustration induction) was significantly different between the H-ADHD and L-ADHD groups. The H-ADHD group reported higher levels of frustration compared to the L-ADHD group in response to the frustration induction in the experimental condition (Fig. 1; refer to Table 3 for reports of means and standard deviations). Follow-up analyses (individual repeated measures ANOVAs for H- and L-ADHD groups in both conditions) indicated that there was no change in self-reported levels of frustration in the control condition (L-ADHD group: $F(1, 20) = 0.88$, $p = .358$, $\eta_p^2 = 0.042$; H-ADHD group: $F(1, 19) = 1.33$, $p = .263$, $\eta_p^2 = 0.066$). In the experimental condition, there was no change in frustration levels in the L-ADHD group ($F(1, 20) = 0.06$, $p = .803$, $\eta_p^2 = 0.003$), while the change in levels of frustration approached significance in the H-ADHD group ($F(1, 19) = 3.58$, $p = .074$, $\eta_p^2 = 0.159$).

Additionally, there was a significant condition by induction-time interaction ($F(1, 39) = 8.34$, $p = .006$, $\eta_p^2 = 0.176$). This finding suggested that if we do not consider whether the participants were in either the L- or H-ADHD group, the relationship between the two induction times (pre- and post-frustration induction) was different between the two conditions (control and experimental). Specifically, there was a difference between pre- and post-frustration induction in the experimental condition when frustration was induced (Pre- $M(SD)$ = 1.48(0.32), Post- = 2.10(0.36)) but not in the control condition (Pre- $M(SD)$ = 1.90(0.35), Post- = 1.60(0.36)).

The PANAS item with the biggest self-reported impact was frustration. Results examining the other items from the PANAS did not yield any significant three-way interactions of condition by induction-time by group.

3.3. Primary analyses

We utilized a mixed-analysis repeated measures ANOVA to examine BART explosions across the two conditions between the groups, with condition as the within-subject factor and group as the between-subject factor. Results indicated no significant main effects of condition or group. However, there was a significant group by condition interaction ($F(1, 39) = 4.77$, $p = .035$, $\eta_p^2 = 0.109$; Fig. 2). The groups did not differ in exploded balloons in the control condition; in the experimental condition, however, there was a difference in the number of exploded balloons. Follow-up analyses (individual repeated measures ANOVAs

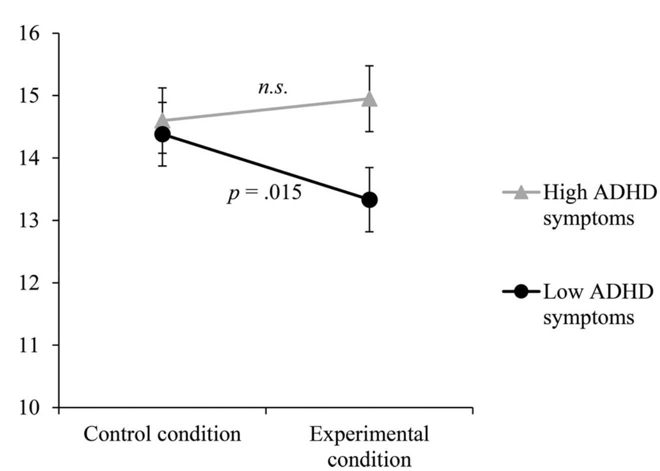

Fig. 2. BART balloon explosions as a function of ADHD group and conditions.

for H- and L-ADHD groups) indicated a non-significant difference in the number of balloons exploded between the control and experimental conditions for the H-ADHD group ($F(1, 19) = 0.47$, $p = .500$, $\eta_p^2 = 0.024$). However, the L-ADHD group exploded significantly less balloons in the experimental condition ($F(1, 20) = 7.10$, $p = .015$, $\eta_p^2 = 0.262$; see Table 3 for means and standard deviations).

4. Discussion

The present study examined risk-taking behavior with a laboratory paradigm among college students with and without elevated ADHD symptoms. College-aged individuals with high or low levels of ADHD symptoms participated in two sessions: a control condition where no mood induction occurred and an experimental condition where frustration was induced.

Results from the manipulation check revealed that the H-ADHD group reported a change in frustration levels that approached significance (a difference of 1.05 between pre- and post-self-reported frustration levels, $p = .074$, $\eta_p^2 = 0.159$) following the mood induction compared to participants in the L-ADHD group (a change of 0.048 in pre- to post-self-reported frustration levels, $p = .803$, $\eta_p^2 = 0.003$). We expected to see a change in frustration levels overall after the mood induction in the experimental session compared to the control session, but examining each group separately pre- to post-induction in both conditions did not yield significant differences in self-reported frustration levels. Instead, the overall higher ratings in frustration following the frustration manipulation were driven by the H-ADHD group. Participants with higher ADHD symptoms reported higher levels of frustration across both sessions, with an even higher level of frustration in the experimental condition. This result is consistent with findings from previous studies (e.g., Scime and Norvilitis, 2006) in which children with ADHD became more frustrated compared to children without the disorder when completing a challenging task. Our results suggest that older individuals with more ADHD symptoms continue to feel more frustration compared to those with less ADHD symptoms. This finding is particularly relevant when understanding and treating college-aged individuals with ADHD; approximately 2% to 4% of college students report clinically significant levels of ADHD symptoms (Weyandt et al., 2013), and more research is necessary to examine college students with ADHD symptoms as they are at greater risk for academic and psychological difficulties (Weyandt and DuPaul, 2008) and for engaging in risky behaviors (Rooney et al., 2011, 2012).

Additionally, it is notable that we chose to examine frustration levels a priori, which was the only item that resulted in a three-way interaction of Condition by Induction-time by Group, where the H-ADHD group reported feeling more frustrated post-mood induction compared to pre-mood induction in the experimental session compared to in the control session. The other PANAS items yielded no such similar result.

Lastly, participants with low levels of ADHD symptoms (the L-ADHD group) exploded fewer balloons on the BART, particularly in the experimental session when frustration was induced, compared to the comparison group with more ADHD symptoms (the H-ADHD group). This finding suggests that participants with lower levels of ADHD symptoms respond to frustration with behavioral inhibition, or at least with behavior that is more inhibited than that of their peers with ADHD. Probing the interaction yielded interesting and unexpected results. The L-ADHD group exploded significantly fewer balloons in the experimental session after a frustration induction compared to in the control session; however, it is important to note that levels of frustration did not change from pre- to post-mood induction in the experimental condition for the L-ADHD group, despite this significant change in balloon explosions. It could be that the frustration induction was not strong enough for the L-ADHD group, or perhaps these individuals regulate their emotions differently compared to the H-ADHD group. On the other hand, the H-ADHD group reported feeling more frustrated following our mood induction procedure, though this frustration did not lead to change in behavior. It is possible that these individuals may be risky regardless of the emotional condition or situation. In other words, the situation may not matter in contributing to their decision to engage in risk-taking behavior. Furthermore, a body of literature suggests that there exists a motivational deficit in individuals with ADHD, such that those with the disorder do not modify their behavior as reward conditions change (Kollins et al., 1997; Volkow et al., 2009). Without a strong enough reward or incentive to inhibit behavior, individuals, such as children with ADHD (Slusarek et al., 2001) will be less likely—and possibly less motivated—to change their behavior given the circumstance.

The finding that individuals with low levels of ADHD symptomatology became less risky suggests that L-ADHD individuals may become less prone to engage in risk-taking behavior, or may become more risk aversive. This finding could be due to the fact that we used an extreme groups design to examine risk behavior in individuals with low versus high ADHD symptoms instead of examining symptomatology continuously. We examined two items from the PANAS, "Jittery" and "Nervousness," as these items are closest to capturing anxiety and are synonymous with behavioral inhibition. Results indicated no significant three-way interactions of Condition by Induction-time by Group (Jittery: $F(1, 39) = 0.21$, $p = .652$, $\eta_p^2 = 0.005$; Nervousness: $F(1, 39) = 0.49$, $p = .488$, $\eta_p^2 = 0.012$). In examining pre- to post-mood induction in the experimental condition, the interactions of Induction-time by Group only approached significance (Jittery: $F(1, 39) = 0.67$, $p = .418$, $\eta_p^2 = 0.017$; Nervousness: $F(1, 39) = 2.68$, $p = .110$, $\eta_p^2 = 0.064$). Future research, particularly examining mediating variables, could examine what causes individuals with lower levels of ADHD to engage in less risky behavior, as evidenced by findings with the BART from the current study.

To our knowledge, this study is the third that has found that control groups (e.g., groups with lower symptomatology) engage in less risky behavior on the BART compared to a clinical sample. Reynolds and colleagues (2013) found that individuals in a high-social anxiety group exploded significantly more balloons in a high-stress condition than in a low stress condition, while the difference in balloon explosions across conditions was nonsignificant for the low-social anxiety group (the control group). More recently, Matusiewicz et al. (2018) found a similar result in a study examining a sample of female participants with Borderline Personality Disorder (BPD) versus a comparison group without the disorder. When distressed, female participants with BPD engaged in more risk-taking on the BART, while those without the disorder engaged in less risk-taking, suggesting that females without BPD became more risk-aversive, especially compared to a control condition when no distress was induced. However, more research to examine the relationship between the impact of frustration on risk-taking behavior in a more normalized, community sample is needed before the conclusion that individuals with low (to no) ADHD symptomatology engage in less risk-taking behavior after participation in a mood-induction task can be made. Additionally, research examining engagement in real-world risk behaviors (e.g., alcohol or substance use, gambling) as the outcome would be beneficial in understanding risk behavior between a group with higher psychopathological symptoms compared to a control group, such as those with lower symptoms. Although, previous research supports that BART performance is an appropriate proxy for real-world risk-taking, such as substance use (including early engagement in substance use behaviors) and antisocial behaviors (Dahne et al., 2013). For example, Collado et al. (2014) found that adolescents with more advanced pubertal scores had higher risk-taking scores on the BART-Y and engaged in more real-world risky behavior, such as drank alcohol and gambled for money) compared to adolescents with less advanced pubertal scores.

This study is marked by several limitations. First, because this was a pilot study, our sample size was small; additionally, our sample included more males than females and more Caucasians than members of other groups among those with elevated ADHD symptoms. While both variables (gender and race) were not related to any dependent variable, a future replication study nonetheless should balance key demographic variables across L-ADHD and H-ADHD groups in a larger sample size. Relatedly, our sample was generally high-functioning in that all participants were enrolled in college. Adults with an ADHD diagnosis are less likely to obtain formal education following high school and have lower grades while in secondary school (Glutting et al., 2005). Thus, future research should also examine differences in response to frustration and risky behavior in a more representative sample of young adults with ADHD. Another limitation was that the characterization of ADHD group was based on self-report ratings on the CAARS:SV. Future research could examine the role of negative emotion in the engagement of risk-taking behavior in a clinical sample of young adults with ADHD by establishing groups using full DSM diagnostic criteria, as well as possibly including a longer, more detailed version of the CAARS and corresponding observer rating forms. Finally, the BART provides a proxy for risk-taking in the real world, and future research could explore the impact of frustration on real-world risk behaviors outside of a controlled laboratory setting.

Despite these limitations, the findings from the current study are the first, to our knowledge, to examine ADHD symptomatology and general risk-taking behavior in the context of frustration in a laboratory setting. Our results examining frustration levels in young adults are consistent with previous literature which has found that individuals with ADHD become frustrated more easily than their peers without ADHD (Maedgen and Carlson, 2000; Melnick and Hinshaw, 2000; Oliver et al., 2011; Scime and Norvilitis, 2006; Walcott and Landau, 2004). If future larger-scale studies further replicate and extend these findings, especially to examine the role of frustration, as well as other possible negative emotions, there is great potential opportunity in considering developmentally-appropriate interventions targeting young adults with ADHD. Future studies also could explore why low-symptom groups (e.g., our L-ADHD group) engage in less risky behavior in an experimental condition where negative affect is induced compared to high-symptom groups (e.g., our H-ADHD group).

Finally, results from this study have important implications for understanding emotion regulation and risk-taking in the context of frustration among young adults in college. Emotion regulation is especially important to understand among college students, as they are required to regulate emotions independently, without the assistance of an external source such as a parent or guardian figure.

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