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Negative Urgency and Lack of Perseverance Predict Suicidal Ideation and Attempts Among Young Adolescents

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ABSTRACT

Objective: Impulsivity has been recognized as an important factor in suicidal thoughts and behaviors (STBs). However, previous research linking impulsivity to STBs has largely relied on cross-sectional designs, considered only a subset of impulsivity measures, and typically focused on middle-to-older adolescents. Here, we explored multiple measures of impulsivity and assessed their predictive relation to suicidal ideation and suicide attempts.

Method: In a sample of 10,286 adolescents (ages 9–12; 47.4% female, 76.4% White, 19.4% Black, 6.4% Asian, 3.5% American Indian/Alaskan Native, 0.6% Native Hawaiian/Pacific Islander, 6.4% Other, 19.4% Hispanic, 12.1% Mixed/Multiple Race) from the Adolescent Brain Cognitive DevelopmentSM Study (ABCD Study[®]), we assessed impulsivity when youth were 9–10 years old, and suicidal ideation and attempts when youth were 11–12 years old. We measured impulsivity in three ways: a trait-like measure (UPPS-P Impulsive Behavior Scale), a behavioral measure (delay discounting task), and a neural measure (Cortical Delay Discounting [C-DD]). Suicidal ideation and attempts were assessed using the Kiddie Schedule for Affective Disorder and Schizophrenia (KSADS) suicide module.

Results: Negative urgency and lack of perseverance (at ages 9–10) significantly predicted a higher likelihood of suicidal ideation (*Negative Urgency*: Odds Ratio [OR] = 1.254, $p < .001$; *Lack of Perseverance*: OR = 1.152, $p = .035$) and suicide attempts (*Negative Urgency*: OR = 1.328, $p = .009$; *Lack of Perseverance*: OR = 1.270, $p = .009$) when youth were 11–12 years old.

Conclusions: Negative urgency and lack of perseverance are robust predictors of future suicidal ideation and suicide attempts in young adolescents. These findings highlight the importance of assessing for and targeting these dimensions of impulsivity in clinical settings.

Suicide is a major cause of premature death worldwide, especially among adolescents, a demographic who has shown alarming increases in suicide over the last decade (Joseph et al., 2022). Among young adolescents (10–14 years old), the rate of death from suicide has more than doubled from 1.3 per 100,000 to 2.8 per 100,000 youth over the last two decades (Curtin & Garnett, 2023). In part because of the personal, economic, and social toll of suicide, extensive attention has been paid to elucidating risk factors associated with suicidal thoughts and behaviors (STBs). Impulsivity has been well established as a risk factor for STBs (Joiner, 2005; Klonsky et al., 2016). However, the unique contributions of distinct facets of impulsivity for explaining STBs have not been thoroughly evaluated in adolescents. The present study examined multiple facets of impulsivity to evaluate their role in explaining future suicidal ideation and attempts in early adolescence, a developmental period when risk for suicide starts to increase (Curtin & Garnett, 2023).

Trait Impulsivity

Trait impulsivity, or the tendency to act rashly across contexts, has been considered a key risk factor for STBs (Joiner, 2005; Klonsky et al., 2016), given the central role behavioral dysregulation plays in carrying out self-injurious behaviors. Self-report questionnaires have been used to quantify the dimensions of trait impulsivity, with the UPPS-P Impulsive Behavior Scale (UPPS-P) representing one of the most widely utilized measures (Cyders et al., 2007). The UPPS-P assesses five dimensions of trait impulsivity which have been theorized to represent interconnected, yet separable, pathways to impulsive action: (1) *Lack of Premeditation*, indicating impulsive actions taken without forethought; (2) *Lack of Perseverance*, reflecting challenges in sustaining motivation for task completion; (3) *Sensation Seeking*, denoting a tendency to seek out exhilarating experiences; (4) *Positive Urgency*, signifying impulsive reactions driven by positive

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emotions; and (5) *Negative Urgency*, indicating impulsive responses triggered by negative emotions (Cyders et al., 2007; Whiteside & Lynam, 2001).

Much of the research on impulsivity and STBs has employed the UPPS-P scale. Individual studies and meta-analyses have documented cross-sectional associations between positive and negative urgency, lack of premeditation, as well as lack of perseverance, and suicidal ideation in middle or high school-aged adolescents (Harman et al., 2021; Klonsky & May, 2010) and in adults (Beach et al., 2022; Bruno et al., 2023; Valderrama et al., 2022). Similarly, negative urgency, lack of premeditation, and lack of perseverance all have been shown to distinguish individuals who attempt from those who do not attempt suicide (Auerbach et al., 2017; Beach et al., 2022; Bruno et al., 2023; Harman et al., 2021; Klonsky & May, 2010). However, research on the relationship between impulsivity and STBs, especially for suicide attempts, also have documented mixed results (Millner et al., 2018) or null effects after adjusting for relevant factors such as depression (Anestis et al., 2014). Therefore, at best, the extant literature suggests that trait dimensions of impulsivity are correlates of suicidal ideation, but research is less clear on whether they are correlates of suicide attempts (Anestis et al., 2014; Klonsky et al., 2016). The discrepancy in findings across studies may, in part, be due to small sample sizes and the inconsistent use of relevant covariates in the models (e.g. depression, other psychopathology) (Bruno et al., 2023). Further, there has been a lack of longitudinal studies to determine whether any trait impulsivity dimension(s) predict STBs prospectively and relatively few studies with samples of younger adolescents. A longitudinal study in a large young cohort would address an important gap in the literature and possibly offer evidence for trait impulsivity dimensions being a risk factor, rather than a correlate, of STBs.

Impulsive Decision-Making in a Reward Context

Another facet of impulsivity that has been examined in relation to STBs in adolescents is impulsive decision-making in the context of reward (Lamontagne et al., 2023; Liu et al., 2017; Mathias et al., 2011; McHugh et al., 2019). Delay discounting indexes impulsive choice for reward or the extent to which people devalue future, larger rewards over sooner, smaller rewards and is measured using behavioral and neural indicators (Koffarnus & Bickel, 2014; Odum, 2011). In behavioral discounting paradigms, participants are asked to choose between a reward that is smaller but available sooner and a reward that is larger but delayed in time. An individual's tendency

to devalue rewards as time until the reward is obtained increases is estimated by the delay-discounting rate (k value) (Odum, 2011).

Prior cross-sectional research has linked steeper delay discounting to higher rates of suicidal ideation in both adolescents and adults (Liu et al., 2017; McHugh et al., 2019). In terms of suicide attempts, results have been mixed regarding the relationship between attempts and steeper delay (Lamontagne et al., 2023; McHugh et al., 2019). Further, no studies have examined whether differences in delay discounting predict suicidal ideation and attempts prospectively (Lamontagne et al., 2023; Liu et al., 2017; McHugh et al., 2019).

In addition to behavioral measures of delay discounting, researchers have recently developed the cortical delay discounting (C-DD) measure, a neurobiological metric of the tendency to undervalue delayed rewards and overvalue immediate rewards using gray matter thickness across the cortex (Sadeh et al., 2023). One potential advantage of using a neurobiological measure of impulsive decision-making in models of risk assessment for psychopathology, including STBs, is the possibility it will facilitate the early identification of individuals who are susceptible to these problems before they manifest. In the validation study, the C-DD was created based on associations between delay discounting performance and gray matter thickness across 148 brain regions in a healthy adult sample and then cross-validated in unseen clinical-community samples with elevated rates of psychopathology (Sadeh et al., 2023). Results of these analyses showed cross-sectional and prospective positive associations between C-DD and delay discounting rate across three samples, and C-DD was positively associated with externalizing disorder symptoms (substance use, alcohol use, antisocial personality), but unrelated to internalizing disorder symptoms (major depression, panic, generalized anxiety, social phobia). Extending these findings, a recent examination of the generalizability of the C-DD metric to early adolescence across two samples (ABCD and community recruitment, $N_s = 9992$ and 56, respectively) reported that C-DD was cross-sectionally associated with delay discounting and externalizing (but not internalizing) psychopathology in both adolescent samples (Bounoua et al., 2023). These findings build upon the initial validation study with adults and provide preliminary evidence C-DD is a useful metric for assaying impulsive decision-making for reward and dimensions of psychopathology characterized by impulsivity (i.e., externalizing symptoms) in adolescence. However, further development and validation is still warranted given the mixed findings in the literature regarding the replicability and utility of biomarkers for predicting risk

for STBs and other psychopathology (Auerbach et al., 2021; Parkes et al., 2020).

Research on the relevance of the C-DD for explaining STBs is still in its infancy and only one study to date to our knowledge has examined these relationships. Sheehan et al. (2023) assessed the utility of the C-DD for understanding who may be at risk for suicidal behavior among adults with a history of trauma exposure. At a bivariate level, C-DD was unrelated to self-directed violence, specifically non-suicidal self-injury and suicide attempts, in this adult sample. However, an interaction effect emerged, whereby C-DD was inversely associated with self-directed violence as experiences of childhood trauma increased (Sheehan et al., 2023). These findings suggest that, although no direct association may be present between C-DD and STBs, this neurobiological measure of impulsive decision-making susceptibility may explain meaningful variance in suicidal behaviors when considered in conjunction with trauma exposure in childhood. Given the limited research on C-DD, investigation of the clinical significance of this neurobiological metric for prospectively predicting STBs across development is needed.

The Present Study

A rich body of research has documented how impulsivity, broadly construed, relates to STBs. However, the existing literature has been limited in three important ways. First, most studies have focused on evaluating associations between impulsivity and STBs cross-sectionally (Anestis et al., 2014; Auerbach et al., 2017; Beach et al., 2022; Bruno et al., 2023; Harman et al., 2021; Klonsky & May, 2010; Millner et al., 2018; Valderrama et al., 2022), limiting knowledge of which measures of impulsivity predict ideation or attempts over a multi-year time period. Such evidence would help establish impulsivity as a risk factor and suggest possible clinical uses of predictive measures.

Second, while studies have shown the potential of trait impulsivity and behavioral measures of impulsivity to predict STBs, no studies have integrated these measures within a single study framework. Self-report and behavioral measures of impulsivity tap different aspects of impulsivity (Eisenberg et al., 2019; Enkavi et al., 2019; Sharma et al., 2014). There is some evidence that self-report measures fare better in terms of relations to real-world risky and impulsive behavior (Eisenberg et al., 2019; Sharma et al., 2014), but behavioral tasks still offer unique information about the mechanisms supporting risky behavior (Eisenberg et al., 2019; Sharma et al., 2014). Thus, including both self-report and behavioral assessments of impulsivity has resulted in better predictions of real-world

behavior (Eisenberg et al., 2019; Sharma et al., 2014). Comparing unique or common influences of impulsivity based on measure type has the potential to be useful for the understanding factors supporting and predicting STBs (Eisenberg et al., 2019; Sharma et al., 2014).

Third, despite the increased suicide rate among younger adolescents (Curtin & Garnett, 2023), only a limited number of studies have investigated impulsivity and STBs in this population. There has been insufficient investigation of impulsivity and STBs in this younger and more impulsive age group (Romer, 2010).

There is a need for research using a longitudinal design, multiple measures of impulsivity, and younger adolescents to investigate how facets of impulsivity predict STBs. Using data from the Adolescent Brain Cognitive DevelopmentSM Study (ABCD Study[®]), we aimed to address these limitations by investigating whether different dimensions of trait impulsivity, delay discounting, and C-DD at baseline predict occurrences of suicidal ideation and suicide attempts among a cohort of 10,286 young adolescents 2 years later. Due to research in young adolescents highlighting internalizing and externalizing psychopathology, family conflict, gender and race as relating to STBs (DeVillie et al., 2020; Janiri et al., 2020; Lee & Wong, 2020), we included these measures as covariates of non-interest.

Based on previous research using multi-faceted self-report measures of impulsivity we hypothesized that negative urgency would predict future suicidal ideation and attempts and that lack of premeditation would predict future suicide attempts (Auerbach et al., 2017; Beach et al., 2022; Klonsky & May, 2010). We hypothesized that delay discounting would not be associated with future STBs given the mixed literature and lack of studies that account for the variance associated with psychopathology (Lamontagne et al., 2023; McHugh et al., 2019). We had no specific hypothesis for C-DD because this measure is rather new. We also conducted a supplemental analysis only including participants with suicidal ideation to see whether any dimensions of impulsivity predicted attempts given present or previous suicidal ideation. By understanding how specific dimensions of impulsivity relate to suicidal thinking and behavior in young adolescents, we may improve our knowledge of the processes involved in youth STBs and subsequently how to evaluate youth STBs.

Method

Participants

The participants in this study were youth included in ABCD Study Data Release 5.0 (doi:10.15154/8873-zj65).

The ABCD Study is a longitudinal study of youths at 21 research sites across the United States (see Garavan et al., 2018 for a detailed description of recruitment). The study-wide exclusion criteria at baseline were as follows: lack of English fluency, major medical or neurological conditions, magnetic resonance imaging (MRI) contraindication, history of traumatic brain injury, current diagnosis of schizophrenia, moderate or severe autism spectrum disorder, intellectual disability, and substance use disorder. All caregivers provided informed consent and youth provided assent for participation in the study.

The behavioral and MRI data used in this study were from the baseline assessment when youth were ages 9–10 and 2 years later when youth were ages 11–12. For this study, we excluded participants whose data were missing for the UPPS-P Impulsive Behavior scale, delay discounting task, structural MRI, and youth version of the computerized Kiddie Schedule for Affective Disorders and Schizophrenia (KSADS) for Diagnostic and Statistical Manual for Mental Disorders (DSM-5). Of the original 11,878 participants at baseline 10,286 (see Table 1 for descriptive statistics; see Table 2 for zero-order correlations among key variables) met the inclusion criteria for the current study.

Measures

UPPS-P Impulsive Behavior Scale

Participants answered an abbreviated youth version of the UPPS-P Impulsive Behavior scale developed specifically for use in the ABCD Study, which consisted of 20

questions from the full 59 item version (Watts et al., 2020). All five dimensions of impulsivity – lack of perseverance, lack of premeditation, sensation seeking, negative urgency and positive urgency were represented. Participants rated statements from 1 (agree strongly) to 4 (disagree strongly). Cronbach's alphas were as follows: .63 (Negative Urgency), .78 (Positive Urgency), .74 (Lack of Premeditation), .69 (Lack of Perseverance) and .50 (Sensation Seeking). Participants' responses to each statement were summed, with higher scores indicating more impulsivity, and z-scored.

Delay Discounting

Study participants either chose a hypothetical \$100 reward at several different delay intervals or an immediate reward of varying amounts (Koffarnus & Bickel, 2014). The ABCD data release included participant's indifference points (i.e., the amount at which the participant has an equal preference for the immediate and delayed reward) at each delay interval. We estimated k values (i.e., how much reward value is affected by delay) by non-linear least squares via the following equation: $V = \frac{A}{1+kD}$ where V is the indifference point, A is the large reward amount (\$100), and D is the delay as calculated in days. After the k values were estimated, they were z-scored.

Cortical Delay Discounting (C-DD)

C-DD was calculated based on a T1 weighted scan. All neuroimaging data were collected as part of the ABCD

Table 1. Descriptive statistics.

Demographic Variables	N (10,286) (%)	
Gender	Male, 5397 (52.5%)	Female, 4875 (47.4%)
Race/Ethnicity	White, 7862 (76.4%)	Black, 1994 (19.4%)
Hispanic, 1996 (19.4%)	Asian, 657 (6.4%)	Other, 659 (6.4%)
Mixed Race, 1241 (12.1%)	American Indian or Alaskan Native, 359 (3.5%)	Native Hawaiian or Pacific Islander, 65 (0.6%)
Predictor Variables	Mean	Standard Deviation
Negative Urgency	8.482	2.630
Positive Urgency	7.956	2.942
Sensation Seeking	9.792	2.665
Lack of Premeditation	7.744	2.351
Lack of Perseverance	7.039	2.238
Delay Discounting	-5.582×10^{-10}	6.433×10^{-8}
Cortical Delay Discounting	-0.355	1.209
Covariates of Non-Interest	Mean	Standard Deviation
Internalizing	48.431	10.578
Externalizing	45.535	10.222
Family Conflict	2.022	1.952
Suicide Measures	Count at baseline	Count at Year 2
Ideation	476	457
Attempt	77	111

14 participants did not identify as male or female. "Other" was a response participants could select and "Mixed Race" shows how many participants selected two or more racial identities. At baseline, 19 participants reported a lifetime suicide attempt without reporting lifetime suicidal ideation. At Year 2, 17 participants reported a lifetime suicide attempt without reporting lifetime suicidal ideation.

Table 2. Correlation table.

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Suicidal Ideation											
2. Suicidal Attempt	.41** [.39, .42]										
3. Negative Urgency	.08** [.06, .10]	.07** [.05, .09]									
4. Lack of Premeditation	.04** [.02, .06]	.03** [.01, .05]	.15** [.13, .17]								
5. Sensation Seeking	.00 [−.02, .02]	.02 [−.00, .04]	.13** [.11, .15]	.07** [.05, .09]							
6. Positive Urgency	.05** [.03, .07]	.04** [.02, .06]	.49** [.48, .51]	.20** [.19, .22]	.19** [.17, .21]						
7. Lack of Perseverance	.06** [.04, .08]	.05** [.03, .07]	.13** [.11, .15]	.45** [.43, .46]	−.09** [−.11, −.07]	.17** [.15, .19]					
8. Externalizing	.10** [.08, .12]	.09** [.07, .11]	.17** [.15, .19]	.16** [.14, .18]	.03** [.01, .05]	.14** [.12, .16]	.13** [.11, .15]				
9. Internalizing	.09** [.07, .11]	.09** [.07, .11]	.07** [.05, .09]	.05** [.03, .07]	−.03** [−.05, −.01]	.04** [.02, .06]	.11** [.09, .13]	.58** [.57, .60]			
10. Family Conflict	.07** [.05, .09]	.05** [.03, .06]	.26** [.24, .28]	.21** [.19, .22]	.02 [−.00, .04]	.24** [.22, .26]	.18** [.16, .20]	.18** [.16, .20]	.09** [.07, .11]		
11. CDD	.01 [−.01, .03]	.00 [−.02, .02]	.02* [.01, .04]	−.00 [−.02, .02]	−.02* [−.04, −.00]	.03** [.01, .04]	−.00 [−.02, .02]	.02 [−.00, .04]	−.01 [−.03, .01]	.02* [.00, .04]	
12. Delay Discount	.02* [.00, .04]	.00 [−.02, .02]	.04** [.03, .06]	.01 [−.01, .03]	−.03** [−.05, −.01]	.08** [.06, .10]	.02* [.00, .04]	.02* [.00, .04]	.01 [−.01, .03]	.04** [.02, .06]	.04** [.02, .05]

The 95% confidence interval for each correlation is shown. * indicates $p < .05$. ** indicates $p < .01$.

Study on Siemens Prisma, Philips and GE 750 3T scanners using a 32-channel head coil (Casey et al., 2018). The DAIRC for the ABCD Study preprocesses all MRI data correcting for issues like head motion, between-scan motion and more. C-DD was developed in a previous study using a multivariate additive model of gray matter thickness across the brain (Sadeh et al., 2023). Areas of cortex were weighted based on how much cortex thickness there related to delay discounting using the beta weights from the validation study. Higher C-DD corresponded to thinner cortex and greater preference for immediate reward (Sadeh et al., 2023). The C-DD values were z-scored.

Suicidal Ideation and Attempts

Participants completed the youth version of the computerized Kiddie Schedule for Affective Disorders and Schizophrenia (KSADS) for Diagnostic and Statistical Manual for Mental Disorders (DSM-5). Participants were asked if they “ever” experienced ideation or made a suicide attempt at each timepoint. We created binary variables to indicate the presence (past or present) or absence of each symptom for (1) suicidal ideation (wishing to be dead or wanting to end one’s own life without method or plan; *ksads_23_147_t*, *ksads_23_148_t*, *ksads2_23_138_t*, *ksads2_23_139_t*) and (2) suicide attempt (*ksads_23_149_t*, *ksads_23_150_t*, *ksads2_23_140_t*, *ksads2_23_141_t*) at the 2-year-follow-up point. We measured lifetime suicidal ideation and attempts at the 2-year-follow-up point and included lifetime suicidal ideation and attempts at baseline as covariates.

Covariates of Non-Interest

Risk factors for STBs include mental illness, depression, and hopelessness (Klonsky et al., 2016), as well as family conflict in younger samples (DeVile et al., 2020; Janiri et al., 2020). We included internalizing and externalizing psychopathology (Child Behavioral Checklist; Achenbach, 1999), family conflict (Youth Family Environment Scale-Family Conflict Subscale Modified from PhenX (FES-FCS) (Hoffman et al., 2019)), race and ethnicity (dummy coded for each race/ethnicity category as 1 if a participant identified a that category), and gender (coded 1 for female and 0 for male/non-binary participants [14 participants did not identify as male or female]) as covariates of non-interest in all analyses.

Statistical Models

In R (4.4.1), we estimated logistic regression models (“stats:” R Core Team, 2024) to investigate the relationship between youth reported impulsivity at baseline and STBs at the 2-year follow-up. For both suicidal ideation and suicide attempts, we ran independent models (one for each measure of impulsivity) and a simultaneous model including all seven measures of impulsivity – five UPPS dimensions, delay discounting and C-DD – and covariates. Additionally, we considered whether any measure(s) of impulsivity predicted the suicide attempts among those who reported suicidal ideation at baseline or the 2-year-follow-up point by running a simultaneous model that only included participants with suicidal ideation. Based on the sampling method of the ABCD Study,

we clustered standard errors for family and site (“sandwich:” Zeileis et al., 2020; “lmtest:”; Zeileis & Hothorn, 2002). False discovery rate was used to correct for multiple comparisons in each set of analyses (Benjamini & Hochberg, 1995). Supplement Table 1 displays variable comparisons for any missing data at the 2-year-follow-up. None of the primary variables showed a difference between participants with or without missing data at the 2-year-follow-up. We also tested whether the measures included in the simultaneous models were multicollinear (Supplement Tables 2–4). The Variance Inflation Factor and Tolerance metrics showed no indication of multicollinearity. Finally, we might be concerned whether the main results are robust to different assumptions about the proper set of covariates, so we also ran all models without covariates (see Supplement Tables 5–7).

Results

Suicidal Ideation

In the independent logistic regression models, baseline negative urgency, positive urgency and lack of perseverance predicted suicidal ideation 2 years later (Table 3). No other variables of interest were significantly associated with suicidal ideation 2 years later.

In the simultaneous model, baseline negative urgency and lack of perseverance again predicted suicidal ideation 2 years later (Table 3). The simultaneous logistic regression model explained 4.8% of the variance in suicidal ideation. No other measures of impulsivity were significantly associated with suicidal ideation 2 years later in the simultaneous model.

Suicide Attempts

In the independent logistic regression models, baseline negative urgency, positive urgency and lack of perseverance predicted suicide attempts two years later (Table 4). No other variables of interest were significantly associated with suicide attempts two years later.

In the simultaneous model, baseline negative urgency and lack of perseverance again predicted suicide attempts two years later (Table 4). The simultaneous logistic regression model explained 7.5% of the variance in suicide attempts. No other measures of impulsivity were significantly associated with suicide attempts two years later in the simultaneous model.

Suicide Attempts Among Individuals with Suicidal Ideation

In a simultaneous logistic regression model only including individuals with suicidal ideation, only lack of perseverance predicted suicide attempts 2 years later (Table 5). This model explained 6.9% of the variance in suicide attempts among individuals with suicidal ideation.

Robustness

Consistent with the main analyses, in independent logistic regression models without covariates, negative urgency, positive urgency, lack of premeditation and lack of perseverance predicted suicidal ideation 2 years later (Supplement Table 5). In a simultaneous logistic regression model without covariates, negative urgency and lack of

Table 3. Impulsivity and suicidal ideation.

Impulsivity Measure	Independent Models				Simultaneous Model ($n = 10286$, R^2 Tjur = 0.048)		
	OR	CI	p	R^2 Tjur	OR	CI	p
Negative Urgency	1.266	1.161–1.380	<0.001	0.045	1.254	1.135–1.384	<0.001
Positive Urgency	1.115	1.035–1.201	0.015	0.041	0.979	0.891–1.075	0.869
Sensation Seeking	1.033	0.937–1.138	0.656	0.041	1.026	0.926–1.137	0.706
Lack of Premeditation	1.104	1.007–1.211	0.083	0.041	1.010	0.901–1.131	0.706
Lack of Perseverance	1.166	1.062–1.280	0.006	0.043	1.152	1.031–1.288	0.035
Delay Discounting	1.085	0.978–1.204	0.219	0.041	1.088	0.979–1.208	0.219
Cortical Delay Discounting	1.039	0.952–1.134	0.570	0.042	1.040	0.948–1.142	0.570
Covariates of Non-Interest in Simultaneous Model							
Hispanic	0.975	0.759–1.251					
Female	1.917	1.542–2.382					
Black	1.105	0.843–1.448					
Asian	0.900	0.563–1.440					
AIAN	1.280	0.930–1.761					
Internalizing	1.236	1.110–1.377					
Externalizing	1.196	1.094–1.308					
Family Conflict	1.096	1.000–1.201					
Baseline Ideation	4.519	3.251–6.281					

Sample sizes for the independent models are as follows: $n = 10785$ for UPPS dimensions, $n = 10409$ for delay discounting and $n = 10668$ for C-DD. All p -values are false discovery rate corrected. See Supplement Table 3 for Variance Inflation Factor and Tolerance.

Table 4. Impulsivity and suicide attempts.

Impulsivity Measure	Independent Models				Simultaneous Model ($n = 10286$, R^2 Tjur = 0.075)		
	OR	CI	p	R^2 Tjur	OR	CI	p
Negative Urgency	1.317	1.128–1.539	0.007	0.074	1.328	1.105–1.594	0.009
Positive Urgency	1.161	1.033–1.305	0.034	0.070	0.988	0.822–1.186	0.510
Sensation Seeking	1.087	0.920–1.284	0.510	0.070	1.155	0.940–1.418	0.963
Lack of Premeditation	1.072	0.938–1.224	0.510	0.071	0.930	0.810–1.067	0.397
Lack of Perseverance	1.240	1.090–1.411	0.008	0.073	1.270	1.087–1.484	0.009
Delay Discounting	1.003	0.837–1.201	0.978	0.068	1.016	0.836–1.235	0.963
Cortical Delay Discounting	0.931	0.787–1.101	0.567	0.073	0.941	0.777–1.141	0.685
Covariates of Non-Interest in Simultaneous Model							
Hispanic					1.488	0.980–2.260	
Female					2.119	1.467–3.060	
Black					1.013	0.540–1.902	
Asian					1.181	0.499–2.797	
AIAN					1.315	0.652–2.653	
Internalizing					1.614	1.249–2.084	
Externalizing					1.280	1.006–1.627	
Family Conflict					1.061	0.905–1.243	
Baseline Ideation					4.519	3.251–6.281	
Baseline Attempt					5.670	2.372–13.550	

Sample sizes for the independent models are as follows: $n = 10785$ for UPPS dimensions, $n = 10409$ for delay discounting and $n = 10668$ for C-DD. All p -values are false discovery rate corrected. See Supplement Table 3 for Variance Inflation Factor and Tolerance.

perseverance predicted suicidal ideation 2 years later (Supplement Table 5). This model explained 3.5% of the variance in suicidal ideation. Further, examining suicidal ideation at the 2-year-follow-up point among those who reported no baseline ideation or attempts, negative urgency was related to new cases of suicidal ideation 2 years later (Supplement Table 8).

In independent logistic regression models without covariates, negative urgency, positive urgency and lack of perseverance predicted suicide attempts 2 years later (Supplement Table 6). In a simultaneous logistic regression model without

covariates, negative urgency and lack of perseverance predicted suicide attempts 2 years later (Supplement Table 6). This model explained 5.1% of the variance in suicide attempts. Among individuals with suicidal ideation, a model without covariates showed that only lack of perseverance predicted suicide attempts 2 years later (Supplement Table 7). This model explained 4.1% of the variance in suicide attempts among individuals with suicidal ideation. Finally, an analysis looking at suicide attempt at the 2-year-follow-up point among those who reported no baseline ideation or attempts, lack of perseverance related to new

Table 5. Impulsivity and suicide attempts among individuals with suicidal ideation.

Impulsivity Measure	OR	CI	p
Negative Urgency	1.194	0.973–1.466	0.203
Positive Urgency	0.864	0.719–1.037	0.203
Sensation Seeking	1.183	0.936–1.495	0.222
Lack of Premeditation	0.881	0.757–1.026	0.203
Lack of Perseverance	1.263	1.107–1.441	0.004
Delay Discounting	0.924	0.758–1.126	0.433
Cortical Delay Discounting	0.909	0.728–1.136	0.433
Covariates of Non-Interest in Simultaneous Model			
Hispanic	1.631	0.843–3.155	
Female	1.866	1.141–3.052	
Black	0.998	0.490–2.032	
Asian	1.284	0.545–3.024	
AIAN	1.240	0.611–2.513	
Internalizing	1.353	1.030–1.778	
Externalizing	1.144	0.901–1.454	
Family Conflict	0.939	0.805–1.010	
Baseline Attempt	3.013	1.453–6.249	

A simultaneous Model (R^2 Tjur = 0.069) on $n = 837$. All p -values are false discovery rate corrected. See Supplement Table 4 for Variance Inflation Factor and Tolerance.

cases of suicide attempt 2 years later (Supplement Table 9).

Discussion

Adolescent suicide is a significant public health concern. Recent trends suggest that adolescent suicide rates have been increasing, and the onset of this problem also has been getting younger (Curtin & Garnett, 2023). Previous research in adolescents has identified different aspects of impulsivity as important factors related to STBs (Auerbach et al., 2017; Harman et al., 2021; Klonsky & May, 2010). However, much of the past research has been plagued by the predominance of cross-sectional designs, the use of only a subset of impulsivity measures, and has been limited in assessing younger adolescents. The current study addressed these limitations by examining the relationship between several dimensions of impulsivity and STBs 2 years later in a large sample of young adolescents. Results of the study showed that higher negative urgency and lack of perseverance were robust predictors of suicidal ideation and suicide attempts among young adolescents.

Prominent theories of suicide posit that impulsivity, broadly defined, is a factor associated with suicidal ideation (Joiner, 2005; Klonsky & May, 2015; O'Connor & Kirtley, 2018). The present findings suggest that negative urgency, impulsivity specifically in response to or in avoidance of negative affect, and lack of perseverance, reflecting challenges in sustaining motivation for task completion, are the components of impulsivity most robustly related to suicidal ideation. Though speculative, maladaptive coping strategies among individuals with higher negative urgency and lack of perseverance may contribute to suicidal ideation. In fact, negative urgency has been associated with a preference for reflexive responses or disengagement among possible emotional regulation strategies (Johnson et al., 2020; King et al., 2018; Riley et al., 2015; Roxburgh et al., 2022). Individuals who engage in behaviors with limited forethought to avoid negative affect may struggle to utilize more adaptive coping strategies, rely on emotion-focused coping (e.g., self-blame) and avoidant coping (e.g., behavioral disengagement), and ultimately express suicidal ideation. Similarly, individuals with difficulties following through or completing an activity when it is difficult or boring (i.e., lack of perseverance) also may struggle to use adaptive coping strategies. These individuals might prefer more immediate or easier – but less adaptive – strategies and again ultimately express suicidal ideation.

Negative urgency and lack of perseverance also predicted suicide attempts in adolescents in our main analyses. However, in the follow-up analysis among adolescents with suicidal ideation, only lack of perseverance predicted suicide attempts. Most people who have suicidal ideation do not go onto attempt suicide (Joiner, 2005; Klonsky et al., 2016). However, disrupting the progression from thought to action, to some extent, necessitates persevering through thoughts and experiences that evoke high levels of negative affect and distress, or adopting and maintaining effective coping strategies to manage this affect (Joiner, 2005; Klonsky & May, 2015; O'Connor & Kirtley, 2018). Difficulty inhibiting behavior in the face of negative affect or a weakened ability to sustain motivation for stopping urges for suicidal behavior may increase the likelihood of transitioning from thought to action. As noted above, less effective coping strategies, which have been associated with these two trait dimensions, may amplify an individual's capacity for attempting suicide (Anestis et al., 2014; Johnson et al., 2020; King et al., 2018; Riley et al., 2015; Roxburgh et al., 2022). The results for those with suicidal ideation suggest that lack of perseverance, as a measure of impulsivity, may be particularly related to attempting suicide (see also Supplemental Table 9).

Beyond negative urgency and lack of perseverance, other measures of trait impulsivity or behavioral impulsivity showed inconsistent or null effects in the present study. In independent models (with covariates but without other measures of impulsivity) positive urgency predicted suicidal ideation and suicide attempts. Positive urgency and negative urgency are highly correlated traits (Watts et al., 2020), therefore, it is unsurprising that higher positive urgency predicts STBs when negative urgency is unaccounted for statistically. When negative urgency and positive urgency are included in models together, the null result for positive urgency suggests that positive affective impulsivity is not predictive of STBs beyond the tendency of those with more negative affective impulsivity to also experience more positive affective impulsivity. Two traits – sensation seeking and lack of premeditation – as well as our behavioral and neural measures of impulsivity – delay discounting and C-DD – did not predict suicidal ideation or suicide attempts. Sensation seeking had not been previously found to relate to STBs in similar age groups (Harman et al., 2021; Klonsky & May, 2010), and only one study, to our knowledge, in high-school students found a relationship between higher lack of premeditation and suicidal ideation (Klonsky & May, 2010). Delay discounting and C-DD are both reward-related measures, so the null results in the present study and previously in the

literature (McHugh et al., 2019) suggest that impulsivity related to rewards may not be a facet of impulsivity with relevance to STBs. Overall, individual differences in negative affect reactivity and perseverance may be particularly important to the relationship between impulsivity and STBs. In future work, it may be beneficial to consider measures of impulsive behavior and neural correlates of impulsivity that engage these dimensions.

There are a few important limitations to the study that contextualize these results. First, we only considered two time points early in the ABCD Study. As new data is released, subsequent research can track whether the relationship between impulsivity and suicide changes over the course of adolescence. Second, the ABCD Study data are limited to lifetime STBs or STBs within the past 2 weeks of assessment. Researchers using the ABCD dataset will need to acknowledge these timescales and develop appropriate questions given these timescales. In the present study, we used an annual timescale to identify long-term risk factors for STBs. Recent work in suicidal adults also showed that people with more recent suicide attempts reported higher negative urgency (Millner et al., 2018). Therefore, negative urgency continuously appears as an important risk factor across timescales. However, future research is needed to integrate the predictive value of negative urgency as a trait with the possibility that changes in negative urgency may be a mechanism involved in suicide attempts. Furthermore, more precision in the measurement time scale may guide our understanding of the individual contributions of negative urgency and lack of perseverance. In research on non-suicidal self-injury, for example, the onset of non-suicidal self-injury was related to negative urgency and continuance of non-suicidal self-injury was related to lack of perseverance (Riley et al., 2015). Finding a similar temporal relationship between these dimensions of trait impulsivity for suicidal ideation and attempts would be an important step forward. Third, it should be noted that the effect sizes for the measures of impulsivity, namely negative urgency and lack of perseverance, were relatively modest compared to other factors such as gender and internalizing psychopathology (see Tables 3–4). Therefore, these dimensions of impulsivity should be viewed as accounting for some of the variance associated with STBs but should not be viewed as the only or even strongest risk factors. They simply provide an evidence base for a subset of risk factors and potential targets for intervention. Finally, data were not available to account for interventions, such as therapy or new medications, in between our baseline measurement and 2 years later.

The dramatic increase in suicides among adolescents – especially younger adolescents – calls for identifying risk factors that may be targeted during

interventions. The current study finds that young adolescents higher in negative urgency and lack of perseverance are more likely to experience suicidal ideation and are more likely to attempt suicide. Among adolescents with suicidal ideation, those higher in lack of perseverance are more likely to attempt suicide. Impulsive behaviors with negative affect and that lack perseverance may be two important clinical targets for young adolescents with suicidal ideation.

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