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SUICIDE (R LIU, SECTION EDITOR)

Neurocognitive Processes Implicated in Adolescent Suicidal Thoughts and Behaviors: Applying an RDoC Framework for Conceptualizing Risk

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Abstract

Purpose of Review Identifying risk factors for STBs during adolescence is essential for suicide prevention. In this review, we employ the Research Domain Criteria (RDoC) framework to synthesize studies on key neurocognitive processes—cognitive control, reward responsiveness/valuation, and negative urgency—relevant to adolescent STBs.

Recent Findings Within subdomains of cognitive control, studies of inhibition/suppression and updating/maintenance were mixed, while response selection (i.e., decision-making) deficits were consistently associated with suicide attempts. Fewer studies, by comparison, have probed the Positive Valence Systems. Relative to healthy controls, adolescents with prior STBs may show a blunted neural response to rewards and value rewards less, but findings require replication. Finally, negative urgency, which may span subdomains within both cognitive control and the Positive Valence Systems, was associated with recent suicide attempts in the only study to directly test this association.

Summary Few studies have examined neurocognitive functioning in relation to adolescent STBs, despite the relevance of this research to detecting suicide risk. We recommend that future studies incorporate developmental contexts relevant to both neurocognitive processes and STBs.

Keywords RDoC · Suicide · Cognitive control · Reward responsiveness · Negative urgency

Introduction

Suicide is the second leading cause of death among children, adolescents, and young adults [1]. As rates of suicidal thoughts and behaviors (STBs) surge in adolescence [2], identifying risk factors during this developmental stage is essential for preventing suicide. Few suicide theories, however, explicitly relate to adolescents [3], and research has generally applied a downward extension of adult models to youth. Although this may be helpful, it may limit the identification and understanding of processes uniquely linked to STBs among adolescents, or that play a more central role in youth suicides.

Decades of suicide science have shown that oft-examined demographic and clinical characteristics do not predict suicide-related outcomes much above chance [4]. Consequently, to improve the prevention of STBs, there has been a call to examine novel, transdiagnostic suicide risk factors [5••, 6, 7]. The Research Domain Criteria (RDoC) provides a framework focusing on dimensions that cut across psychiatric symptoms and represents constructs at multiple units of analysis. Thus, it has immense promise for uncovering novel risk factors that may be translated to targets for prevention and intervention efforts.

The goal of this review is to apply the RDoC framework to catalogue and synthesize prior studies on key neurocognitive processes that are relevant to STBs in youth. We focus on three

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broad neurocognitive processes—cognitive control (Cognitive Systems), reward responsiveness/valuation (Positive Valence Systems), and negative urgency (Cognitive Systems; Positive and Negative Valence Systems). These processes are reviewed because their associations with STBs have been conceptualized within suicide theories [8–10], and there is a growing corpus of empirical work in adolescents (see Table 1). We end by summarizing developmental considerations and future directions to move research in these areas forward.

Cognitive Control

Cognitive control reflects a suite of abilities that allow an individual to adapt their thoughts, attention, and/or behavior to achieve goals. Specific functions include inhibiting poor responses, selecting, updating, and sustaining attention on goals, and selecting optimal responses given one's goals (e.g., decision-making). Collectively, cognitive control abilities are critical for problem-solving and future planning, and deficiencies in these functions are implicated in several leading suicide theories. For instance, escape theories propose that, for some, negative life events generate intolerable emotional distress. When this aversive state is coupled with poor cognitive control, individuals cannot produce or execute effective coping strategies, making suicide seem like the only way to relieve one's distress [30–32]. Recently, ideation-to-action frameworks (see [33]) have suggested that the predictors and correlates of suicidal ideation—such as emotional pain and distress—are likely distinct from factors that drive the transition to suicide attempts among ideators. Consistent with these frameworks, we [16•] and others have proposed that deficits in cognitive control may be uniquely associated with attempts, even among ideators.

Inhibition and Suppression Of the subconstructs within the RDoC's cognitive control construct, inhibition and suppression have been most extensively investigated in the context of adolescent STBs. Inhibition requires that one override or suppress a prepotent, overlearned, and/or typical response. Behavioral tasks that capture inhibition require that participants respond to target stimuli as quickly as possible, but withhold responses under specific conditions (e.g., Stop-signal; Go/No-Go). Poor inhibition is reflected in more *commission errors* or failure to withhold responses when one is signaled to do so. Two studies using Stop-signal and Go/No-Go tasks, respectively, found a significant association between poorer inhibition (i.e., more commission errors) and suicide attempts among mid-to-late adolescents [11•, 13]. In contrast, two other studies found no differences in inhibition between

Table 1 The association between deficits in neuropsychological processes and suicidal thoughts and behaviors (STBs) among youth

RDoC construct	Subconstruct	Measure	Positive findings	Null findings
Cognitive Control	Inhibition/suppression	Stop-signal task	[11•]	[12]
		Go/No-Go	[13]	[14]
		Classic Stroop	[11•]	[15]
		Suicide Stroop task	[16•]	
		Flanker		[17]
	Updating, representation, and maintenance	Continuous performance task	[18]	[11•, 15, 19]°
	Response selection	Iowa Gambling Task^	[20, 21]	[22]
Positive Valence Systems	Anhedonia+	Questionnaires†	[23–25]	[16•, 26, 27]
	Reward responsiveness	Reward positivity to winning versus losing money	[28•, 29]	
	Reward valuation	Effort-cost computation task	[23]	
		Two Choice Impulsivity Paradigm§	[13, 14]	

RDoC Research Domain Criteria

° Both [11•, 19] found evidence that commission errors on a continuous performance task were associated with suicide attempts among youth with histories of childhood maltreatment; however, the main effects in the full samples were non-significant

^ One study ([22]) used the Cambridge Gambling Task, which is very similar to the Iowa Gambling Task

+ According to the RDoC, anhedonia is classified in the Positive Valence Systems as a "nonspecific" subconstruct

† Four of the studies listed in this section ([16•, 23, 26, 27]) used the Snaith-Hamilton Pleasure Scale. The remaining two studies used an anhedonia scale drawn from widely used measures of depressive symptoms: the Children's Depression Scale [24] and the Reynolds Adolescent Depression Scale—2nd Edition (RADS-2) [25]

§ The Two Choice Impulsivity Paradigm measures delay-discounting. In these studies, relative to non-attempters, attempters showed greater delay-discounting. This suggests that they are less willing to expend the effort of waiting for a reward; this is consistent with evidence from the Effort-Cost Computation Task [23] attempters and non-attempters in clinical samples [12, 14]. These mixed results may be partly due to heterogeneity in sample characteristics (hospitalized females [14]; offspring of depressed parents [11•]; male and female self-injurers [13]; depressed outpatients [12]) and/or limited statistical power in three of four cases (*n*s per group < 32). Further work is warranted to identify subgroups of adolescents for whom disinhibition may be linked to suicidal behavior.

Interference suppression tasks (e.g., Flanker, Stroop) also require inhibition, as well as focused attention on task relevant stimuli. For instance, in the classic Stroop, participants name the color in which words are printed (task goal), while ignoring word content (task-irrelevant information) that can either be congruent (e.g., "green" written in green ink) or incongruent (e.g., "green" written in red ink) to the goal. Interference is the extent to which reaction times (RTs) are slower on incongruent relative to congruent trials. Adult research consistently shows interference suppression deficits among suicide attempters relative to healthy and psychiatric controls (e.g., [15, 34]); however, the few adolescent studies have been mixed. Among adolescents with a history of a mood disorder, poorer interference suppression was associated with higher odds of a prior suicide attempt [11•], but this effect was non-significant among currently depressed adolescents [15]. Further, first-degree relatives of adolescent suicide attempters—a group at elevated risk for suicide—did not show poorer interference suppression compared to relatives of healthy adolescents on a Flanker task [17].

Collectively, behavioral studies of inhibition/suppression and STBs among adolescents have focused on performance in neutral conditions. However, suicide theories suggest that disinhibition contributes to suicidal behavior when youth are distressed. We [16•] used the Suicide Stroop task (SST) [35] wherein words are emotional (negative, positive, and suicide-relevant) or neutral. We found that, relative to depressed adolescent suicide ideators, depressed attempters exhibited greater interference from emotional words (i.e., slower RTs to emotional versus neutral words). These findings suggest that adolescents at risk for suicide may have difficulty inhibiting or suppressing negative cognitions (e.g., dejection, hopelessness, and/or suicidal urges) in emotionally provocative situations, triggering attempts for some. However, a recent mega-analysis of SST studies [36], including the work described above [16•], indicated that interference scores on the SST show poor internal consistency, pointing to a need to potentially refine this measure. Additional studies of adolescents' inhibition and suppression abilities that employ emotional stimuli or that experimentally induce negative emotional states are critical for testing further hypotheses derived from suicide theory.

Updating, Representation, and Maintenance The updating, representation, and maintenance subconstruct has been examined in the context of adolescent STBs using continuous performance tasks (CPTs). CPTs measure sustained attention on, and engagement with, a task goal (e.g., responding to targets embedded within many non-targets) for a long period of time without interruptions. An initial study of adolescent psychiatric inpatients found that, relative to non-attempters, attempters made both more commission errors and omission errors (i.e., failing to respond to a target) suggesting problems with goal maintenance and/or sustained attention [18]. Subsequent studies have failed to replicate this effect among depressed adolescent psychiatric patients [15, 19], or offspring of parents with mood disorders [11•]. Despite these results, there is emerging evidence that goal maintenance and/or sustained attention may be associated with STBs in subgroups of adolescents reporting past or ongoing maltreatment. Among depressed adolescents, we found that CPT commission errors were associated with prior suicide attempts among those with a history of sexual abuse, but not those without [19]. Relatedly, Zelazny and colleagues [11•] found that better sustained attention was associated with lower odds of suicide attempts, but this protective effect was not significant among adolescents with a history of maltreatment. Overall, the role of goal maintenance and/or sustained attention in adolescent STBs is unclear; given non-significant main effects, additional moderators (e.g., life stressors; emotion regulation) should be tested.

Response Selection A tendency to make disadvantageous choices on behavioral tasks is characteristic of adult suicide attempters [10, 34], and across several adolescent studies, these findings replicate. Using the Iowa Gambling Task (IGT [37]), two studies have demonstrated that, relative to non-attempters, adolescent attempters chose the high-risk decks (i.e., possible gains and losses are both larger but result in net losses) more often overall [20, 21]. Further, adolescent non-attempters chose advantageous decks on a progressively greater number of trials over the course of the IGT, while attempters did not [20]. This pattern may reflect a reduced ability to draw on past experiences to guide future decision-making among attempters. Decision-making deficits of this nature may leave youth at risk for suicide ill-equipped to change or reappraise emotionally painful circumstances, making their pain seem permanent and increasing suicide risk. Interestingly, adolescent ideators with no history of attempts do not show disadvantageous decision-making relative to non-ideators [22]. To determine whether decision-making deficits are a specific marker of adolescent suicide attempts, versus ideation more generally, a critical next step is to compare these abilities in well-characterized clinical samples of ideators and attempters (see [38]).

Converging Neuroimaging Evidence Broadly, cognitive control is associated with activation of the prefrontal cortex (PFC) and its interaction with other brain areas (e.g., reward and motor regions) [39]. Functional magnetic resonance imaging (fMRI) studies using emotional stimuli have provided evidence of abnormalities in neural regions supporting cognitive control among youth with STBs. Pan et al. [40] computed neural activation corresponding to viewing angry faces (relative to a fixation cross) in a sample of depressed youth. They found that, relative to non-attempters, attempters had (a) increased activation in the right anterior gyrus and dorsolateral PFC and (b) reduced functional connectivity between the anterior cingulate gyrus and bilateral insulae. Relatedly, youth with bipolar disorder and a history of suicide attempts showed reduced functional connectivity between the amygdala and the left ventral PFC while viewing emotional (happy, fearful) and neutral faces compared with patient non-attempters [41]. The findings indicate that attempters may have problems regulating and appropriately deploying attention, as well as planning and executing behavioral responses, in emotional contexts.

Summary Although mixed, studies suggest that poor cognitive control is associated with STBs among adolescents. The clearest effects in behavioral tasks are reduced interference suppression and poorer decision-making in attempters versus non-attempters, in line with adult findings [10]. As research has largely compared attempters and non-attempters, the degree to which cognitive control deficits are associated with suicide attempts, independent of ideation, is unknown. More generally, studies have used a range of paradigms to assess distinct aspects of cognitive control, typically in isolation. Using consistent operationalization of subconstructs within cognitive control, and measuring multiple subconstructs simultaneously, is critical for better characterizing deficits most relevant to adolescent STBs.

Reward

Anhedonia—difficulty experiencing pleasure—has been frequently examined in the context of STBs. From an RDoC perspective, anhedonia is classified in the Positive Valence System as a "nonspecific" subconstruct (i.e., not linked to a single RDoC construct; see [5••]) and is associated with reduced reward responsiveness, learning, and valuation (see [42]). Consistent with escape theories of suicide [30–32], scholars have proposed that anhedonia contributes to STBs because it is painful, experienced as intolerable, and viewed as unchangeable [23, 24].

In an early study of psychiatrically hospitalized children, more severe anhedonia was associated with greater suicide ideation and higher odds of an attempt; further, anhedonia was the only measured variable that differentiated ideators from attempters [24]. In line with these findings, higher anhedonia has been found to distinguish adolescent self-injurers with a history of attempts from those with no prior attempts [25] and depressed attempters from ideators [23]. However, these studies included modest samples of attempters, and effects have not been replicated in subsequent, larger studies (e.g., [16•, 26, 27]). In light of these mixed results, future research may benefit from moving beyond a monolithic conceptualization of anhedonia (see [43]). Anhedonia reflects a group of affective, cognitive, and behavioral components; quantifying the unique contributions of each component to adolescent STBs may resolve discrepancies across studies and clarify which subcomponent of anhedonia is most strongly linked to suicide in youth.

Reward Responsiveness Reward responsiveness reflects neural activity following reward receipt (e.g., monetary gains, social acceptance). A series of electroencephalogram (EEG) studies has probed an event-related potential (ERP) known as the Reward Positivity (RewP) elicited by monetary rewards and losses in the context of a guessing task [44]. The RewP is enhanced (more positive) to rewards versus losses, reflects early reward recognition/categorization (see [45]), and may be associated with enhanced activation in subcortical reward regions (e.g., [46]). In two studies, a blunted RewP (i.e., a smaller difference between response to rewards relative to losses) was found in (a) children of suicide attempters (versus children of non-attempters) and (b) children with recent suicide ideation (versus clinical controls with no ideation) [28•, 29]. Converging evidence from an fMRI study indicates that, relative to healthy youth, self-injuring adolescents (many with a history of suicide attempts) had reduced activation of the putamen, amygdala, and orbitofrontal cortex to cues indicating the possibility of winning money (subconstruct: reward anticipation) [47]. Taken together, these results suggest that reward responsiveness may be linked to STBs in youth, but studies that more precisely classify youth according to the nature of their STBs (e.g., ideators versus attempters versus clinically matched controls) are necessary to support firmer conclusions.

Reward Valuation Reward valuation (i.e., computing probability and benefits of potential outcome) has been sparsely studied in the context of adolescent STBs. One exception is a study in which we [23] examined the behavior of depressed adolescent ideators and attempters on an effort-cost computation task (ECCT; [48]). In the ECCT, participants could choose an easy option (i.e., less effort) that yielded a small monetary reward or a difficult option for a larger reward. The probability of reward receipt was explicit and either 100% or 50% depending on the trial. Attempters were less willing to choose the difficult option than ideators, but only when rewards were uncertain. Further, while ideators were significantly more likely to choose the difficult option on trials proceeding winning money, attempters did not show this effect.

Supporting our findings, relative to non-attempters, attempters may prefer to receive smaller value rewards sooner compared with larger rewards later (i.e., greater delay-discounting [13, 14]). Thus, attempters are less willing to expend the effort of waiting for reward. Taken together, adolescent attempters may not get the same hedonic benefit from rewards: they are less willing to work for them, wait for them, and do not use them to guide future choices. We speculate that these characteristics leave some youth mired in negative affect and that suicidal desire (and behaviors) may follow.

Summary It is challenging to draw conclusions about the role reward deficits play in adolescent STBs because of the heterogeneity with respect to sample characterization (e.g., types of STBs) and methodology (e.g., self-report, behavioral tasks, neuroimaging). Mixed findings regarding relations among self-reported anhedonia and STBs signal an opportunity to systematically examine distinct aspects of reward processing within the same sample at multiple units of analysis. For instance, when coupled with EEG/ERP, the Monetary Incentive Delay Task (MIDT; [49]) can quantify behavioral (RT) and neural (cue-P3; RewP; feedback-related P3) indices of reward anticipation and initial response to reward. Further, computational modeling can be applied to neural and behavioral responses to the MIDT, yielding a reward prediction error value that captures one aspect of reward learning. Going forward, we encourage the use of methods that more comprehensively assess reward processing among youth with STBs.

Negative Urgency

Impulsivity is an umbrella term that, in its broadest sense, captures poor self-control, manifested in problems sustaining attention, acting without thinking things through, and an inability to delay gratification [50]. Models of trait impulsivity emphasize dysfunction in both cognitive control systems in the PFC and mesolimbic regions implicated in reward processing (see [51]). Thus, relations between impulsivity and STBs may reflect broader neurocognitive abnormalities spanning multiple RDoC domains, some which we have described.

In a recent meta-analysis, impulsivity showed modest concurrent associations with STBs, and effect sizes for predicting future suicidal behavior were near zero [52]. This has led some scholars to propose that *negative urgency*, a subtype of impulsivity that involves rash actions in the context of negative affect [53], may be more relevant to STBs than other forms of impulsivity [54, 55, 56•]. Among adolescents, indirect support for the link between negative urgency and STBs comes from the latter's associations with mental disorders linked to high suicide risk, such as substance abuse disorders [57], eating disorders [58], and borderline personality disorder traits [59]. Further, we have found that general risky behaviors that are often linked to negative urgency (e.g., unsafe sex; truancy; physical fights; risky driving) are associated with suicide attempts [26, 60] among hospitalized adolescents.

To our knowledge, only one study has directly examined associations among negative urgency and STBs in youth. In a large sample of inpatients, we rigorously characterized impulsivity using a 3-factor model (i.e., negative urgency, lack of perseverance, reflexive negative thoughts; see [61]) and tested associations with STBs (i.e., ideation, plans, and attempts). We found that *only* negative urgency was associated with the frequency of suicide attempts in the past month, over and above the effects of suicide ideation and plans, psychiatric symptom severity, and the other two forms of impulsivity [62•]. Thus, there is a potentially unique effect of negative urgency on suicidal behavior, which has implications for better understanding why some, but not all, ideators transition from suicidal thoughts to action—one of the foremost priorities in our field [38].

Converging Neuroimaging Evidence It also is critical to elucidate the behavioral and neural processes that may subserve negative urgency, as doing so might point to early emerging processes that could act as prevention targets. Unfortunately, evidence for the potential neural correlates of negative urgency comes exclusively from adult samples. Using structural MRI with healthy adults, Muhlert and Lawrence [63] found that higher self-reported negative urgency was uniquely associated with smaller gray matter volumes in the dorsomedial PFC and right temporal pole, controlling for other forms of impulsivity. Thus, neural regions implicated in response inhibition and perspective taking may be relevant to negative urgency. Functional MRI studies also have shown that high negative urgency was related to greater dorsolateral and ventromedial PFC activation while adults (a) inhibited a prepotent response and simultaneously viewed a negative image (versus when they viewed a neutral image) [64] and (b) during incongruent (versus congruent) trials of the classic Stroop task [65]. Finally, there is evidence that negative urgency may be uniquely linked to impaired response inhibition (e.g., Go/NoGo performance) and not other aspects of cognitive control (e.g., interference suppression, sustained attention, decision-making (see [66, 67]). However, the only study to directly investigate the neural correlates of response inhibition in adolescent attempters versus non-attempters found no neural abnormalities in response inhibition regions [12]. The potential links between negative urgency and neural circuitry supporting disinhibition among youth awaits further systematic study.

Summary People with high trait negative urgency act reflexively in ways they may regret when they are feeling sad, anxious, hopeless, and/or angry. It is thus tremendously relevant to the manner in which suicidal behavior is generally described and understood. Most theories assume suicidal behaviors occur in the context of emotional distress and/or pain, and the final decision to make an attempt may occur within minutes of action [68]. Nonetheless, limited research has been directed towards negative urgency and its relation to STBs in youth. Of particular importance is establishing the neurocognitive basis of negative urgency, which may be centered on poor response inhibition in the context of emotional arousal [66, 67]. Some studies have primed mood states prior to cognitive control tasks [69] or measured arousal during such tasks [70]; these studies show that self-reported urgency is associated with task performance when participants are emotionally aroused. Coupling these tasks with EEG/ERP or fMRI is an avenue for uncovering the mechanisms underlying negative urgency and their relations to suicidal behavior in youth.

Developmental Considerations

The neurocognitive processes reviewed—and their putative neural substrates— undergo pronounced change during adolescence. At the same time, rates of STBs surge from near zero in childhood to adult levels by late adolescence [2]. Thus, considering both the normal and atypical trajectories of cognitive control, reward processing, and negative urgency is critical for understanding their relations with STBs (see [5••, 71]). Models of typical neural development in adolescence point to the immaturity of the PFC and other cortical structures relative to the limbic system as a cause of increased sensation seeking and goal-directed behavior in this period [72, 73]. It is possible that an atypical (e.g., delayed) developmental trajectory of cognitive control regions may contribute to STBs and dangerous risk-taking during middle-to-late adolescence. Further, the ventral striatum and other reward regions in typically developing adolescents show heightened responding to incentives compared with children and adults (e.g., [74, 75]). The heightened motivational salience of rewards, particularly those relevant to social dynamics and status, promotes a surge of learning, exploration, and skill acquisition (see [76••]). Consequently, reduced reward responding may contribute to suicidogenic environments; for instance, lower healthy sensation seeking may lead to fewer social opportunities, reducing felt connectedness (see [77]). Finally, trait impulsivity also increases from childhood to a peak in mid-adolescence, then declines in early adulthood, and this decline may be shallower in attempters relative to non-attempters [78]. Ultimately, considering the typical and atypical developmental courses of neurocognitive processes holds tremendous promise for clarifying how and why STBs onset and escalate during adolescence.

Developmental psychopathology emphasizes the role of transactions between neural circuit-level vulnerabilities and key environmental contexts, and this is a powerful, underused framework for understanding STBs (see [5••, 79]). As adolescents are particularly sensitive to their social environments (e.g., [80•]), especially peer and romantic relationships, exploring transactions among neurocognitive factors and interpersonal stressors may be critical to improve the prediction of adolescent STBs. Indeed, we have found that being bullied [60, 81] and stressors featuring interpersonal loss [27] are uniquely associated with adolescent suicide attempts. It is essential to examine how these developmentally salient stressors moderate and/or mediate the effects of neurocognitive abnormalities on STBs.

More generally, the prevalence of many forms of psychopathology rises rapidly in adolescence [82]. As mental disorders are associated with STBs in youth [2], it is important to consider the timing of their onset vis-à-vis neurocognitive deficits relevant to STBs. Mental disorders may contribute to neurocognitive abnormalities, which in turn increase the likelihood of future STBs. Conversely, pre-existing neurocognitive abnormalities are related to the onset of some mental disorders in youth (e.g., [83]), and thus may lead to STBs indirectly through worsening psychiatric symptoms and functional impairment. And, yet, another possibility is that neurocognitive risk factors lead to STBs independent of mental disorders. Ultimately, STBs are equifinal outcomes, and their causes are complex. Adopting a more developmentally sensitive research approach is critical for advancing knowledge of adolescent suicide.

Conclusions

Experiencing STBs in adolescence has long-term negative sequelae, including increased rates of mental disorders and treatment utilization, poor overall functioning (financial, health, social), higher risky/illegal behaviors, and future STBs [84, 85]. Thus, intervening prior to the development of STBs would curb a long-term course of disability with vast personal and societal costs. The research on relations between the neurocognitive processes reviewed here (cognitive control, reward responsiveness/valuation, and negative urgency) and STBs among adolescents is in its infancy, and in many cases, the patterns of effects are mixed. Additional focus on these neurocognitive processes is warranted, as they may be useful early indicators of suicide risk. Specifically, there is evidence that unaffected individuals at high-risk for STBs (e.g., family history of suicide attempts) show deficits similar to youth with current STBs in certain cognitive control abilities [86] and reward responsiveness [29]. Further, as research advances on the precise neurocognitive characteristics of youth at high-risk for STBs, this work may inform novel treatments. For example, Peckham and Johnson [87] recently demonstrated that a 6-session cognitive control training program reduced negative urgency in those high in emotion-relevant impulsivity. Ultimately, using research-informed neurocognitive processes to identify high-risk children and pre-teens and to inform creative and effective early interventions holds immense promise for improving the safety and well-being of youth.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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