Transdiagnostic mechanisms in internalizing and externalizing psychopathology: The role of
effortful control in reflexive responding to emotion

Sarah H. Sperry & Neil D. Woodward

Vanderbilt University Medical Center, Department of Psychiatry and Behavioral Sciences

This manuscript is currently submitted but has not been peer-reviewed

Author Note

This research was supported, in part by the National Institute of Mental Health (R01 MH115000), the Charlotte and Donald Test Fund, and the Vanderbilt Institute for Clinical and Translational Research (1-UL-1-TR000445) from the National Center for Research Resources. The opinions expressed are solely those of the authors and not those of the funding sources. This study leveraged the Enhanced Nathan Klein Institute – Rockland Sample (NKI-RS) which was available to N.D. Woodward. This project did not include human subjects research at Vanderbilt University Medical Center. As such, there is no institutional review board identifier. Results from the current project have not been presented elsewhere.

S.H. Sperry is now at the University of Michigan. Correspondence concerning this article should be addressed to Sarah Sperry, Department of Psychiatry, University of Michigan, 4250 Plymouth Road, Ann Arbor, MI, 48109, Email: sperrys@med.umich.edu

Abstract

Emotion-based impulsivity is a transdiagnostic construct related to both internalizing and externalizing behaviors. The Reflexive Responding to Emotion (RRE) framework proposes one possible mechanism through which emotion-based impulsivity predicts two phenotypically different presentations – poor effortful control in the face of strong negative and positive affect can result in either approach or avoidance tendencies. In the present study, we tested this theoretical model in a large developmental community sample, the Enhanced NKI-RS sample (Adult_n = 708, Adolescent_n = 367), which has a wide range of psychopathology and healthy functioning. Using structural equation path modeling, we tested our primary hypothesis that heightened negative or positive affect would be associated with internalizing and externalizing behaviors indirectly through activation control (avoidance) or inhibitory control (approach) facets of effortful control. In adolescents, pathways consistent with the RRE framework for negative urgency emerged such that there was a significant indirect path from negative affect to activation control to internalizing and from negative affect to inhibitory control to externalizing. There was no evidence of positive urgency pathways in the adolescent sample. In contrast, distinct pathways emerged for negative and positive affect in the adult sample – both indirectly led to internalizing psychopathology through activation control and externalizing psychopathology through inhibitory control. Results provide empirical support for the theoretical RRE model and highlight differential cognitive mechanisms through which heightened emotion states may lead to distinct impulsive action or *in*action. Implications of these results are discussed, particularly as they relate to differential intervention targets for emotion-based impulsivity in transdiagnostic populations.

Keywords: emotion-based impulsivity, urgency, effortful control, internalizing, externalizing

General Scientific Summary: Some people have the tendency to respond to negative and positive emotions with impulsive actions or impulsive avoidance or inaction. What determines this? This study highlights that way people self-regulate, either through inhibiting behavioral responses, or the ability to activate when not motivated, is related to how emotional states are differentially related to internalizing or externalizing behaviors.

Introduction

Limitations of current categorical nosology in the Diagnostic and Statistical Manual for Mental Disorders (DSM; American Psychiatric Association, 2013) and International Classification of Diseases (ICD; World Health Organization, 1992) are increasingly coming to the forefront. As such, efforts in psychiatry and clinical psychology are underway to refine the classification of psychopathology, with two primary initiatives emerging –the Research Domain Criteria (RDoC; Cuthbert and Insel, 2013) and the Hierarchical Taxonomy of Psychopathology (HiTOP; Kotov et al., 2017). RDoC and HiTOP are complimentary frameworks that emphasize dimensional characterizations of cognitive, affective, and behavioral symptoms and suggest that the identification of specific and non-specific mechanisms underlying psychopathology is of utmost importance (Micheline et al., 2021). In line with these goals, increased attention to mechanisms underlying *emotion-based impulsivity*, a transdiagnostic developmental construct reflecting poor cognitive control over emotions (Johnson et al., 2013), is warranted.

Emotion-based Impulsivity

Emotion-based impulsivity is classically defined as ill-advised or rash action in reaction to the experience of strong emotions (e.g., Carver et al., 2008; Cyders and Smith, 2008, 2007; Whiteside and Lynam, 2001). Initial models of emotion-based impulsivity defined two constructs – negative and positive urgency. Negative urgency was defined as rash action in the face of distress or negative affect (Whiteside & Lynam, 2001) whereas positive urgency was defined as rash action in the face of heightened positive affect (e.g., celebration/elation; Cyders and Smith, 2008, 2007). These initial conceptualizations of emotion-based impulsivity emphasized approach-related behaviors such as substance use, gambling, risky sexual

behaviors, and non-suicidal self-injury (Cyders & Smith, 2007; Zapolski et al., 2009). Not surprisingly, emotion-based impulsivity was purported as a construct most relevant to externalizing psychopathology (Settles et al., 2012). However, numerous empirical studies established that emotion-based impulsivity is robustly associated with internalizing psychopathology (e.g., depression/anxiety; Berg et al., 2015; Carver et al., 2011; Johnson et al., 2013; Marmorstein, 2013; Smith et al., 2013). This is somewhat surprising as internalizing psychopathology is often characterized by a failure to pursue relevant goals (Jacobson et al., 2001), and high levels of avoidance (Kotov et al., 2017). In an effort to reconcile this counterintuitive finding, Carver et al. (2008) proposed a complimentary model of emotion-based impulsivity, reflexive responding to emotion (RRE).

The RRE framework is drawn from cognitive and developmental theories at its core. First, two-mode models of cognition suggest that humans have two “modes” of functioning – an automatic, reflexive, bottom-up mode, and a rational, reflective, top-down mode (e.g., Norman, 1986; Sloman, 1996). Second, developmental theories of effortful control (e.g., Nigg, 2000) posit that individuals’ can be characterized by the extent to which they are sensitive to stimuli (e.g., attentional management) and able to engage inhibitory control (e.g., suppress an ill-advised behavior). Using these theories, Carver et al. (2008) suggested that individuals who are high in emotion-based impulsivity are characterized by a reflexive system which is very responsive to emotions triggered by cues in the environment. In combination with low effortful control when demands require it (heightened emotion state), these individuals pursue automatic behaviors without consideration for future consequences. Importantly, for some individuals, this can manifest as an inability to pursue an action that they do not want to do

(e.g., inability to persist in the face of a boring task). In this way, individuals can respond to heightened emotion with both impulsive approach pursuits *or* reflexive freezing and avoidance. It is this distinction that potentially identifies the ways in which emotion-based impulsivity relates to two phenotypic presentations – internalizing *and* externalizing psychopathology. Carver’s theory hypothesizes that individuals with low effortful control in the face of strong emotions who have sensitive avoidance systems engage in ill-advised *inaction* (internalizing) whereas individuals who have a sensitive approach system engage in ill-advised *action* (externalizing).

Few studies have examined the RRE model despite its strong theoretical implications. In a path analysis of 261 undergraduate students, Johnson et al. (2017) reported that emotion-triggered impulsive thoughts were particularly relevant to internalizing psychopathology (e.g., depression, anxiety) whereas emotion-triggered impulsive actions were relevant to externalizing psychopathology (e.g., substance use, aggression). Using four independent samples and mini meta-analysis, King et al. (2018) reported that both adolescents and adults high in negative urgency were more likely to use either disengagement or reflexive emotion regulation strategies in the face of negative emotion states or stress. These findings brought to light the possibility that internalizing individuals are more likely to use disengagement as a strategy to decrease intense emotions whereas those who display externalizing psychopathology respond to strong emotion with reactive and reflexive emotion regulation strategies. However, neither study emphasized the cognitive theory underling the RRE model – the role of effortful control as a mechanism that leads to phenotypically diverse presentations in both adolescents and adults.

Effortful Control

Effortful control was first described as an aspect of temperament, reflecting individual differences in the ability to self-regulate (Rothbart, 1989). Effortful control is a multidimensional construct reflecting three distinct but related aspects of self-regulation: attentional control, inhibitory control, and activation control (Evans & Rothbart, 2007). Attentional control refers to the ability to sustain attention as needed. More relevant to the RRE model, inhibitory control refers to the ability to inhibit inappropriate behavior (Rothbart & Rueda, 2005) particularly in the context of suppressing positively toned impulses. In contrast, activation control reflects the capacity to perform an action when there is a strong tendency to avoid it (Evans & Rothbart, 2007) particularly in the context of negatively toned impulses. As such, inhibitory control is thought to be associated with approach behaviors whereas activation control is thought to be associated with avoidance behaviors (Ellis & Rothbart, 2001; Evans & Rothbart, 2007). Individual differences in each of these aspects of effortful control are related to executive functioning (Rothbart et al., 2007), efficiency of the executive attention network (Gerardi-Caulton, 2000), and structural and functional differences in brain regions implicated in the executive attention network (Whittle et al., 2009). Importantly, effortful control is thought to develop within the first year of life and becomes more refined with the maturation of the executive attention network throughout early childhood, late childhood, adolescence, and young adulthood (Rueda et al., 2012). In a recent review, Santens et al. (2020) found that effortful control was related to many forms of internalizing and externalizing psychopathology but highlighted that the necessity of future investigations regarding different facets of effortful control (e.g., activation control, inhibitory control) and their relation to emotion processing.

Goals and Hypotheses

The primary goal of the present study was to empirically test the RRE model and its distinct pathways to internalizing and externalizing psychopathology through effortful control in a large publicly available transdiagnostic community sample. First, we hypothesized that heightened negative and positive affect would be associated with lower activation control and inhibitory control (H1). Next, we hypothesized that activation control would be associated with internalizing psychopathology whereas inhibitory control would be associated with externalizing psychopathology (H2). Our primary hypothesis was to test the proposed pathways of the RRE model – we hypothesized a significant indirect effect between affect, activation control, and internalizing psychopathology (H3) and a significant indirect effect between affect, inhibitory control, and externalizing psychopathology (H4).

Methods

Participants

The current study used a publicly available dataset, the Enhanced Nathan Kline Institute – Rockland Sample (NKI-RS; Nooner et al., 2012), a large community-ascertained epidemiological sample of individuals spanning developmental stages (ages 6 – 85). The NKI-RS includes neuroimaging and genetic data along with neurocognitive, physiological, behavioral, and psychiatric assessments. Both adolescents, adults, and older adults had measures available that tapped negative and positive affect, activation and inhibitory control, and internalizing and externalizing psychopathology (described in detail below). NKI-RS participants contributed data through several sub-studies: (1) Discover Science, (2) Neurofeedback, (3) Adult Longitudinal, and (4) Child Longitudinal. For the purposes of this study, we used data available from all sub-

studies; however, we only included data when collected at the same visit. For example, if someone completed measures of affect 6 months after they completed measures of externalizing and internalizing psychopathology, we did not include that data as it did not reflect the same cross-section and was in the reverse timeframe implied by our statistical models. Given that some questionnaires were administered twice as part of longitudinal components of the study, data collected closest to study enrollment was selected for use in the current study. Demographics, descriptive statistics, and patterns of missingness for the final adolescent ($n = 367$) and adult samples ($n = 708$) are available in Table 1.

Measures

Diagnosis. All participants completed a semi-structured diagnostic interview.

Adolescents and their guardian completed the Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS; Kaufman et al., 1997). The K-SADS assesses current and past episodes of psychopathology according to the Diagnostic and Statistical Manual for Mental Disorders – Fourth Edition Text Revision (DSM-IV-TR; American Psychiatric Association, 2000). The interview was first administered to the parent or guardian and then completed with the adolescent.

Adults completed the Structured Clinical Interview for DSM-IV-TR Axis I Disorders – Non-Patient Edition (SCID-I/NP; First et al., 2002). Adults also completed the Adult ADHD Clinical Diagnostic Scale V 1.2 (ACDS; Kessler et al., 2010), a semi-structured interview that determines presence of ADHD symptoms in childhood. Items on the ACDS match the 18 symptom domains in the ADHD module of the DSM-IV-TR.

Negative and Positive Affect. Negative and Positive Affect was measured with the Early Adolescent Temperament Questionnaire (Revised) Parent Report (EATQ-R; Capaldi and

Rothbart, 1992) for the adolescent sample and the Adult Temperament Questionnaire – Short Form (ATQ- SF; Evans and Rothbart, 2007) for the adult sample¹. The EATQ-R is a 62-item measure of temperament and behavior in children and adolescents (9 to 15). Parents are asked to rate how true each question is of their child on a 5-point Likert scale from 1 (*Almost always untrue*) to 5 (*Almost always true*). For the purposes of this study, parent rated high-intensity pleasure and negative affectivity were used. The negative affectivity subscale is made up of several facets - fear, frustration, shyness, aggression, and depressed mood. The high intensity pleasure subscale includes seven items that assess pleasure and positive affect derived from high intensity activities or novelty.

The ATQ is a 77-item self-report questionnaire for adults that can be administered to participants ages 16 to 85 years old. Participants self-report how much an item describes them on a 7-point Likert scale from 1 (*extremely untrue*) to 7 (*extremely true*). The high-intensity pleasure and negative affectivity subscales were used. The negative affectivity subscale includes facets of fear, sadness, discomfort, and frustration. The high intensity pleasure subscale includes seven items that assess pleasure and positive affect derived from high intensity activities or novelty.

Effortful Control. Activation control and inhibitory control were measured using the parallel EATQ-R and ATQ-SF measures as described above. Activation control is broadly described as executing plans or task performance and is measured using items such as, “I can keep performing a task even when I would rather not do it.” Inhibitory control reflects the

¹ Note that the EATQ-R and ATQ are meant to directly correspond to each other in different age samples. Both scales assess and measure the same temperament and personality measures (Evans & Rothbart, 2007).

behavioral capacity to inhibit impulses and is measured with items such as, “It is easy for me to inhibit fun behavior that would be inappropriate.” The EATQ-R and ATQ-SF include five items each for the activation and inhibitory control subscales.

Internalizing and Externalizing Psychopathology. For the adolescent sample, the Child Behavior Checklist – Parent Report Form (CBCL; Achenbach and Edelbrock, 1991) was used to index internalizing and externalizing psychopathology scores which are based on the DSM-IV oriented syndrome scales. The CBCL is a 113-item informant-report questionnaire that assesses behavioral problems and psychopathology in children ages 6 to 18 within the past six months. Behaviors are rating on a 3-point Likert Scale from 0 (*Not true*) to 2 (*Very true or often true*). Scoring programs for the CBCL provide age and sex normed T-scores for internalizing and externalizing composite scores (Achenbach & Edelbrock, 1991). T-scores ≥ 64 are considered in the clinical range (Achenbach et al., 2001).

For the adult sample, the Adult Self Report (ASR; Achenbach et al., 2003) was used to index internalizing and externalizing psychopathology scores which are based on DSM-IV oriented syndrome scales. The ASR is a 126-item self-report questionnaire and was constructed to parallel the CBCL. Behaviors are rated on the same 3-point Likert scale from 0 (*Not true*) to 2 (*Very true or often true*). The internalizing score is a sum of withdrawal, somatic complaints, anxiety, and depression. Externalizing problems are sums of the items concerning social problems, rule-breaking, and aggressive behavior. These composite scales were then converted into T-Scores. T-scores between 65 and 69 are considered borderline whereas scores ≥ 70 are considered in the clinical range (Achenbach et al., 2001).

Analytic Plan

All data cleaning and analysis was performed in RStudio Version 1.3.1073. R code scripts are available at our OSF page (<https://osf.io/skjh6/>). In order to test our hypotheses, we conducted two structural equation models using the R package *lavaan* (Rosseel, 2012) – a model with the adolescent sample and a model with the adult sample. For each model, internalizing and externalizing T scores were used as the endogenous (outcome) variables with negative affect and positive affect as the exogenous (predictor) variables. Paths were specified from negative and positive affect to activation control and inhibitory control (H1) and from activation control and inhibitory control to internalizing and externalizing psychopathology (H2). We estimated the indirect paths from negative and positive affect to internalizing and externalizing psychopathology through activation and inhibitory control (H3 & H4). Standard errors were calculated based on 1000 bootstrapped samples. Models were estimated using full information maximum likelihood (FIML). We evaluated model fit using CFI, RMSEA, and SRMR based on Hu and Bentler (1999) criteria. Lastly, for both models, age and sex were included as covariates.

Results

Diagnostic information is available for the adolescent and adult samples in Table 1. Sixty-two percent of the adolescent sample qualified for a diagnosis based on the K-SADS interview (Internalizing 34%; Externalizing 28%) with a mean number of diagnoses of one and a range of zero to five diagnoses. Fifty-one percent of adults qualified for a diagnosis based on the ACDS and SCID interview (Internalizing 18%; Externalizing 33%) with a mean of one diagnosis and a range of zero to seven diagnoses. At the time of study participation, the average T-scores for internalizing and externalizing psychopathology in the adolescent sample

were within the average range; however, 13% of adolescents had a T-score in the clinical range on internalizing and 9% had a T-score in the clinical range on externalizing psychopathology. The same was true for the adult sample – at time of study participation the sample was in the average range; however, 9% had an internalizing T-score in the clinical range and 5% had an externalizing T-score in the clinical range. Zero-order correlations between all study variables are provided in Figure 1.

Results of the adolescent model are displayed in Figure 2 and adult model in Figure 3. In addition, full output is available at Open Science Framework (<https://osf.io/skjh6/>). Model fit for both models was excellent based on incremental fit indices (Child CFI = .96; Child SRMR = .03; Adult CFI = .97; Adult SRMR = .03) but poor based on absolute fit (Child RMSEA = .34; Adult RMSEA = .20).

Adolescent Model

Our hypothesis that negative and positive affect would be associated with activation and inhibitory control (H1) was partially supported in the adolescent model. Negative affect was negatively associated with both activation and inhibitory control. However, positive affect was not associated with either. Consistent with expectations, activation control was negatively associated with internalizing psychopathology and inhibitory control was negatively associated with externalizing psychopathology (H2). To our surprise, activation control was also negatively associated with externalizing psychopathology. In support of the RRE model, we found a significant indirect effect between negative affect, activation control, and internalizing psychopathology (H3) and an indirect effect between negative affect, inhibitory control, and externalizing psychopathology (H4). Two findings were not anticipated based on our

hypotheses. First, there was a significant indirect path between negative affect, activation control, and externalizing psychopathology. Second, there were no significant indirect effects with positive affect.

In terms of covariates, in the adolescent sample, age was a significant predictor of externalizing T-score ($\beta = -.55$, $SE = .22$, $p = .01$) and inhibitory control ($\beta = .05$, $SE = .02$, $p = .001$) such that externalizing decreased as age increased and inhibitory control increased as age increased. Sex significantly predicted activation control ($\beta = .26$, $SE = .10$, $p = .006$) such that females had higher average levels of activation control.

Adult Model

Our first hypothesis was fully supported in the adult model. Negative and positive affect were negatively associated with both activation and inhibitory control such that higher intensity of affect was associated with lower activation and inhibitory control. Also consistent with expectations, activation control was negatively associated with internalizing psychopathology and inhibitory control was negatively associated with externalizing psychopathology (H2). Like in the adolescent model, activation control was also negatively associated with externalizing psychopathology. Significant indirect effects between negative affect, activation control, and internalizing psychopathology (H3) and an indirect effect between negative affect, inhibitory control, and externalizing psychopathology (H4) emerged. The adult model diverged from the adolescent model in that the hypothesized indirect effects with positive affect were significant – There was an indirect path between positive affect, activation control, and internalizing psychopathology and with inhibitory control and externalizing psychopathology. Again, like the

adolescent model, there were also significant indirect paths between negative and positive affect, activation control, and externalizing psychopathology.

In the adult model there was a slightly different pattern of results with covariates. Older age was associated with higher internalizing T-scores ($\beta = .05$, $SE = .02$, $p = .02$) but not externalizing T-scores. In addition, older age was associated with greater inhibitory control ($\beta = .01$, $SE = .00$, $p = .02$) and activation control ($\beta = .01$, $SE = .00$, $p = .02$). There were no significant differences in sex in the adult sample.

Discussion

Previous work has established that emotion-based impulsivity is an important transdiagnostic construct related to both internalizing and externalizing behaviors (Berg et al., 2015; Johnson et al., 2017). The RRE framework proposes one possible mechanism through which emotion-based impulsivity predicts two phenotypically different presentations – poor effortful control in the face of both strong negative and positive affect can result in either approach or avoidance tendencies. In the present study, we tested this theoretical model in a large developmental community sample, the NKI-RS sample, which has a wide range of psychopathology and healthy functioning. Our primary hypothesis was that heightened negative or positive affect would be associated with internalizing and externalizing behaviors indirectly through activation control (avoidance) or inhibitory control (approach) facets of effortful control.

In support of the RRE model, structural equation models revealed a significant indirect path between negative affect, inhibitory control, and externalizing and a significant indirect path between negative affect, activation control, and internalizing in both adolescents and

adults. These findings highlight unique mechanisms through which emotion-based impulsivity may be associated with both internalizing and externalizing psychopathology across the developmental lifespan. Specifically, people who have low activation control in the face of heightened negative affect may engage in freezing or avoidance behaviors and are unable to complete necessary behaviors – ultimately perpetuating their negative affective state. In contrast, people who have low inhibitory control in the face of heightened negative affect may engage in approach behaviors such as risky alcohol or drug use or other positively toned activities in an effort to decrease negative affect.

An unanticipated finding was that in both the adolescent and adult samples, a significant indirect path emerged between negative affect, activation control, and externalizing psychopathology. This would suggest that for some, avoidance or freezing behaviors could lead to externalizing behaviors. A clear example of this could be that of ADHD – considered to be an externalizing disorder (Kotov et al., 2017) and categorized as such in the present study. ADHD inattentive subtype is characterized by difficulty sustaining attention, failing to follow through on tasks and instructions, and avoidance of tasks that require sustained mental effort (American Psychiatric Association, 2013). These significant pathways may be characterizing such individuals who are engaging in avoidance behaviors rather than approach behaviors that still have significant implications for socioemotional functioning. Although inhibitory control clearly and robustly emerges as a predictor of externalizing psychopathology, future studies should examine the extent to which activation control plays a mechanistic role in the emergence of both internalizing and externalizing psychopathology.

To our surprise, associations between positive affect, effortful control, and internalizing and externalizing psychopathology differed based on developmental stage. In the adolescent sample, positive affect was not associated with activation or inhibitory control and no indirect paths to internalizing and externalizing psychopathology were found. In contrast, the hypothesized paths between positive affect and activation and inhibitory control were significant, and the hypothesized RRE mechanism through effortful control emerged in the adult sample. Originally, we hypothesized specific associations between positive affect, effortful control, and internalizing and externalizing psychopathology based on the construct of positive urgency and the RRE model. Specifically, both models suggest a subset of individuals engage in impulsive approach behaviors when in high-intensity pleasure states. The RRE model proposes that the mechanisms underlying emotion-based impulsivity are not valence specific – in other words – they apply to both negative and positive urgency (Carver et al., 2008). There is some literature providing support for the idea that high-intensity pleasure or positive affect can impair inhibitory control. For example, patients currently in a manic episode show specific impairments in inhibitory control that do not emerge during depressive episodes (Murphy et al., 1999). In addition, in the one study of our knowledge to specifically examine positive urgency and inhibitory control, Johnson et al. (2016) found a significant association between positive urgency and an antisaccade task of response inhibition. However, a considerable amount of research also fails to find evidence of positive urgency as a construct. In studies that assess positive urgency as a dynamic process using experience sampling methodology in young undergraduate students, positive affect often fails to be associated with momentary reports of impulsivity and the within-person association between positive affect and impulsivity is not

moderated by trait levels of positive urgency (Sperry et al., 2018, 2021). Other studies suggest that pleasant emotions impact inhibitory control to a lesser extent than negative emotions (Wang et al., 2011) and that in some clinical populations, such as treatment seeking gamblers, inhibitory control fails to emerge as a key component in positive urgency processes (Lorains et al., 2014). Taken together, there remains mixed evidence of positive urgency processes, but this literature is complicated by different measurement timescales and types (e.g., ambulatory vs. lab-based behavioral tasks).

Two potential reasons for our findings regarding positive affect are proposed. First, the high-intensity pleasure subscale for adolescents was derived from the EATQ-R, a trait-based questionnaire that has parents assess their child's overall tendency to react with high-intensity pleasure. These types of questionnaires measure the informant's (parent/guardian) perspective on their child's emotion rather than the expressed emotion itself (Zeman et al., 2007). In fact, correlations between parent and self-report EATQ-R subscales are generally only in the medium range ($r = .27 - .46$; Ellis and Rothbart, 2001). As such, parents report of positive affect and high-intensity pleasure may not be capturing the same process as that of the high-intensity pleasure subscale of the ATQ-SF in which adults report on their *own* experience of emotion. If true, an absence of paths with positive affect in the present study reflect a methodological artifact.

Second, some research suggests that negative and positive urgency correlate with age in adolescents such that scores tend to increase and then level off in late adolescents/young adulthood (Littlefield et al., 2016). Specifically, piecewise latent growth models showed significant growth in positive urgency scores from ages 11 to 13 with a significant leveling off from ages 13 to 16. Only 26% of the adolescent sample fell in this age range with significantly

higher cumulative rates at ages below 11 (47%). No research to our knowledge has examined positive urgency in such early ages. As such, it could be that positive urgency as a process is not emerging in our models based on the age and developmental stage of the cohort. These findings highlight the need for future studies of positive urgency in adolescent samples to determine whether the relationship between positive affect, effortful control, and internalizing and externalizing behaviors are unique to adulthood.

These findings have important implications for ongoing physiological, developmental, and neurocognitive studies that aim to elucidate mechanisms underlying emotion-based impulsivity. Specifically, future studies may examine whether there are different neurophysiological signals of activation versus inhibitory control using methods such as electroencephalogram (EEG) that could represent potential novel pharmacological targets within an experimental therapeutics framework. If this were the case, trials could assess whether taking a personalized approach to the treatment of emotion-based impulsivity based on differential neurocognitive reactivity to emotions differentially produces change in internalizing and externalizing psychopathology. Furthermore, if these findings generalize to clinical patient samples, potential psychotherapy mechanisms of change may emerge. Specifically, for those with internalizing psychopathology, emotion-based impulsivity interventions could target freezing or avoidance behaviors in the face of strong affect by bolstering activation control through cognitive trainings. In contrast, for those with externalizing psychopathology, interventions could target distress tolerance and emotion regulation strategies in the face of negative affect by bolstering inhibitory control through cognitive trainings. This would be especially encouraging given preliminary evidence that

cognitive control training may decrease trait levels of emotion-based impulsivity (Peckham & Johnson, 2018).

Limitations

The current study is not without limitations. Emotion-based impulsivity is a dynamic construct reflecting a process that happens *in-the-moment* that at best, can only be approximated with trait measures (Sharpe et al., 2021). The present study examined potential mechanistic pathways between affect, effortful control, and internalizing and externalizing psychopathology at a *trait* level. As such, our findings generalize to relationships *on average* rather than at the finger-grained temporal scale necessary to capture the dynamic unfolding of this process over minutes or hours (e.g., Sperry et al., 2021). None-the-less they have implications for future experience sampling studies that aim to disentangle mechanisms underlying emotion-based impulsivity and suggest the importance of measuring cognitive control *in-the-moment* when individuals experience within-person changes in negative and positive affect. This is increasingly possible with the development of cognitive tasks that can be administered via smartphone applications (e.g., Weizenbaum et al., 2020). In addition, given that collection of the data was not focused on the current question, not all assessment measures of interest were completed in the same individuals. This reduced the total sample size for modeling all paths within the same individual from 367 to 231 in the adolescent sample and from 708 to 704 in the adult sample. Regarding this, we chose to use FIML rather than multiple imputation given the larger sample size and evidence that in structural equation models with missingness, FIML and multiple imputation show negligible differences in parameter estimates (Lee & Shi, 2021).

Conclusion

The current findings shed light on the importance of measuring effortful cognitive control in understanding the link between emotional reactivity and internalizing and externalizing psychopathology. Specifically, clear divergent pathways emerge between affect, activation control, and internalizing psychopathology and between affect, inhibitory control, and externalizing psychopathology providing empirical evidence of the theoretical RRE model. Findings have implications for future mechanistic studies of emotion-based impulsivity and its association with psychopathology.

References

- Achenbach, T. M., Dumenci, L., & Rescorla, L. A. (2001). Ratings of relations between DSM-IV diagnostic categories and items of the CBCL/6-18, TRF, and YSR. *Burlington, VT: University of Vermont*, 1–9.
- Achenbach, T. M., Dumenci, L., & Rescorla, L. A. (2003). Ratings of relations between DSM-IV diagnostic categories and items of the Adult Self-Report (ASR) and Adult Behavior Checklist (ABCL). *Research Center for Children, Youth and Families*.
- Achenbach, T. M., & Edelbrock, C. (1991). Child behavior checklist. *Burlington (Vt)*, 7, 371–392.
- American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders: DSM-IV-TR*. Washington, DC, American Psychiatric Association.
- American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders: DSM-5*. Washington, DC, American Psychiatric Association.
- Berg, J. M., Latzman, R. D., Bliwise, N. G., & Lilienfeld, S. O. (2015). Parsing the heterogeneity of impulsivity: A meta-analytic review of the behavioral implications of the UPPS for psychopathology. *Psychological Assessment*, 27(4), 1129.
- Capaldi, D. M., & Rothbart, M. K. (1992). Development and validation of an early adolescent temperament measure. *The Journal of Early Adolescence*, 12(2), 153–173.
- Carver, C. S., Johnson, S. L., & Joormann, J. (2008). Serotonergic function, two-mode models of self-regulation, and vulnerability to depression: what depression has in common with impulsive aggression. *Psychological Bulletin*, 134(6), 912.
- Carver, C. S., Johnson, S. L., Joormann, J., Kim, Y., & Nam, J. Y. (2011). Serotonin transporter polymorphism interacts with childhood adversity to predict aspects of impulsivity.

Psychological Science, 22(5), 589–595.

Cuthbert, B. N., & Insel, T. R. (2013). Toward the future of psychiatric diagnosis: the seven pillars of RDoC. *BMC Medicine*, 11(1), 1–8.

Cyders, M. A., & Smith, G. T. (2007). Mood-based rash action and its components: Positive and negative urgency. *Personality and Individual Differences*, 43(4), 839–850.

Cyders, M. A., & Smith, G. T. (2008). Emotion-based dispositions to rash action: positive and negative urgency. *Psychological Bulletin*, 134(6), 807.

Ellis, L. K., & Rothbart, M. K. (2001). The early adolescent temperament questionnaire (EATQ-R). *Biennial Meeting of the Society for Research in Child Development, Minneapolis, Minnesota*.

Evans, D. E., & Rothbart, M. K. (2007). Developing a model for adult temperament. *Journal of Research in Personality*, 41(4), 868–888.

First, M. B., Spitzer, R. L., Gibbon, M., & J.B.W., W. (2002). *Structured clinical interview for DSM-IV-TR axis I disorders, research version, non-patient edition (SCID-I/NP)*. Biometrics Research, New York State Psychiatric Institute.

Gerardi-Caulton, G. (2000). Sensitivity to spatial conflict and the development of self-regulation in children 24–36 months of age. *Developmental Science*, 3(4), 397–404.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1), 1–55.

Jacobson, N. S., Martell, C. R., & Dimidjian, S. (2001). Behavioral activation treatment for depression: returning to contextual roots. *Clinical Psychology: Science and Practice*, 8(3),

255.

- Johnson, S. L., Carver, C. S., & Joormann, J. (2013). Impulsive responses to emotion as a transdiagnostic vulnerability to internalizing and externalizing symptoms. *Journal of Affective Disorders, 150*(3), 872–878.
- Johnson, S. L., Tharp, J. A., Peckham, A. D., Carver, C. S., & Haase, C. M. (2017). A path model of different forms of impulsivity with externalizing and internalizing psychopathology: Towards greater specificity. *British Journal of Clinical Psychology, 56*(3), 235–252.
- Johnson, S. L., Tharp, J. A., Peckham, A. D., Sanchez, A. H., & Carver, C. S. (2016). Positive urgency is related to difficulty inhibiting prepotent responses. *Emotion, 16*(5), 750.
- Kaufman, J., Birmaher, B., Brent, D., Rao, U. M. A., Flynn, C., Moreci, P., Williamson, D., & Ryan, N. (1997). Schedule for affective disorders and schizophrenia for school-age children-present and lifetime version (K-SADS-PL): initial reliability and validity data. *Journal of the American Academy of Child & Adolescent Psychiatry, 36*(7), 980–988.
- Kessler, R. C., Green, J. G., Adler, L. A., Barkley, R. A., Chatterji, S., Faraone, S. V., Finkelman, M., Greenhill, L. L., Gruber, M. J., & Jewell, M. (2010). The structure and diagnosis of adult ADHD: an analysis of expanded symptom criteria from the adult ADHD clinical diagnostic scale (ACDS). *Archives of General Psychiatry, 67*(11), 1168.
- King, K. M., Feil, M. C., & Halvorson, M. A. (2018). Negative urgency is correlated with the use of reflexive and disengagement emotion regulation strategies. *Clinical Psychological Science, 6*(6), 822–834.
- Kotov, R., Krueger, R. F., Watson, D., Achenbach, T. M., Althoff, R. R., Bagby, R. M., Brown, T. A., Carpenter, W. T., Caspi, A., & Clark, L. A. (2017). The Hierarchical Taxonomy of

Psychopathology (HiTOP): A dimensional alternative to traditional nosologies. *Journal of Abnormal Psychology*, 126(4), 454.

Lee, T., & Shi, D. (2021). A comparison of full information maximum likelihood and multiple imputation in structural equation modeling with missing data. *Psychological Methods*.
<https://doi.org/http://doi.org/10.1037/met0000381>

Littlefield, A. K., Stevens, A. K., Ellingson, J. M., King, K. M., & Jackson, K. M. (2016). Changes in negative urgency, positive urgency, and sensation seeking across adolescence. *Personality and Individual Differences*, 90, 332–337.

Lorains, F. K., Stout, J. C., Bradshaw, J. L., Dowling, N. A., & Enticott, P. G. (2014). Self-reported impulsivity and inhibitory control in problem gamblers. *Journal of Clinical and Experimental Neuropsychology*, 36(2), 144–157.

Marmorstein, N. R. (2013). Associations between dispositions to rash action and internalizing and externalizing symptoms in children. *Journal of Clinical Child & Adolescent Psychology*, 42(1), 131–138.

Micheline, G., Palumbo, I. M., DeYoung, C. G., Latzman, R. D., & Kotov, R. (2021). Linking RDoC and HiTOP: A new interface for advancing psychiatric nosology and neuroscience. *Clinical Psychology Review*, 102025.

Murphy, F. C., Sahakian, B. J., Rubinsztein, J. S., Michael, A., Rogers, R. D., Robbins, T. W., & Paykel, E. S. (1999). Emotional bias and inhibitory control processes in mania and depression. *Psychological Medicine*, 29(6), 1307–1321.

Nigg, J. T. (2000). On inhibition/disinhibition in developmental psychopathology: views from cognitive and personality psychology and a working inhibition taxonomy. *Psychological*

Bulletin, 126(2), 220.

Nooner, K. B., Colcombe, S. J., Tobe, R. H., Mennes, M., Benedict, M. M., Moreno, A. L., Panek, L. J., Brown, S., Zavitz, S. T., Li, Q., Sikka, S., Gutman, D., Bangaru, S., Schlachter, R. T., Kamiel, S. M., Anwar, A. R., Hinz, C. M., Kaplan, M. S., Rachlin, A. B., Adelsberg, S., ... Milham, M. P. (2012). The NKI-Rockland Sample: A Model for Accelerating the Pace of Discovery Science in Psychiatry. *Frontiers in neuroscience*, 6, 152.

Norman, D. A. (1986). *Reflections on cognition and parallel distributed processing*. In the PDP Research Group (Eds.), *Parallel distributed processing: Explorations in the microstructure of cognition: Vol. 2. Psychological and biological models* (pp. 531-546). Cambridge, MA: MIT Press.

Peckham, A. D., & Johnson, S. L. (2018). Cognitive control training for emotion-related impulsivity. *Behaviour Research and Therapy*, 105, 17–26.

Rosseel, Y. (2012). Lavaan: An R package for structural equation modeling and more. Version 0.5–12 (BETA). *Journal of Statistical Software*, 48(2), 1–36.

Rothbart, M.K. (1989). Temperament and development. In G. A. Kohnstamm, J. E. Bates, & M. K. Rothbart (Eds.), *Temperament in childhood* (pp. 187–247). John Wiley & Sons.

Rothbart, M.K., & Rueda, M. R. (2005). The development of effortful control. In U. Mayr, E. Awh, & S. Keele (Eds.), *Developing individuality in the human brain: A Tribute to Michael I. Posner* (pp. 167–188). American Psychological Association.

Rothbart, M.K., Sheese, B. E., & Posner, M. I. (2007). Executive attention and effortful control: Linking temperament, brain networks, and genes. *Child Development Perspectives*, 1(1), 2–7.

- Rueda, M. R., Checa, P., & Cómbita, L. M. (2012). Enhanced efficiency of the executive attention network after training in preschool children: immediate changes and effects after two months. *Developmental Cognitive Neuroscience, 2*, S192–S204.
- Santens, E., Claes, L., Dierckx, E., & Dom, G. (2020). Effortful Control—A Transdiagnostic Dimension Underlying Internalizing and Externalizing Psychopathology. *Neuropsychobiology, 79*(4), 255–269.
- Sharpe, B. M., Simms, L. J., & Wright, A. G. C. (2021). Impulsivity, affect, and stress in daily life: Examining a cascade model of urgency. *Journal of Personality Disorders, 35*(4), 494–512.
- Sloman, S. A. (1996). The empirical case for two systems of reasoning. *Psychological Bulletin, 119*(1), 3.
- Smith, G. T., Guller, L., & Zapolski, T. C. B. (2013). A comparison of two models of urgency: Urgency predicts both rash action and depression in youth. *Clinical Psychological Science, 1*(3), 266–275.
- Sperry, S. H., Lynam, D. R., & Kwapil, T. R. (2018). The convergence and divergence of impulsivity facets in daily life. *Journal of Personality, 86*(5), 841–852.
- Sperry, S. H., Sharpe, B. M., & Wright, A. G. (n.d.). Momentary dynamics of emotion-based impulsivity: Exploring associations with dispositional measures of externalizing and internalizing psychopathology. *Journal of Abnormal Psychology*.
- Wang, Y., Yang, J., Yuan, J., Fu, A., Meng, X., & Li, H. (2011). The impact of emotion valence on brain processing of behavioral inhibitory control: spatiotemporal dynamics. *Neuroscience Letters, 502*(2), 112–116.
- Weizenbaum, E., Torous, J., & Fulford, D. (2020). Cognition in context: understanding the

everyday predictors of cognitive performance in a new era of measurement. *JMIR MHealth and UHealth*, 8(7), e14328.

Whiteside, S. P., & Lynam, D. R. (2001). The five factor model and impulsivity: Using a structural model of personality to understand impulsivity. *Personality and Individual Differences*, 30(4), 669–689.

Whittle, S., Allen, N. B., Fornito, A., Lubman, D. I., Simmons, J. G., Pantelis, C., & Yücel, M. (2009). Variations in cortical folding patterns are related to individual differences in temperament. *Psychiatry Research: Neuroimaging*, 172(1), 68–74.

World Health Organization (1992). *The ICD-10 classification of mental and behavioural disorders: clinical descriptions and diagnostic guidelines*. World Health Organization.

Zapolski, T. C. B., Cyders, M. A., & Smith, G. T. (2009). Positive urgency predicts illegal drug use and risky sexual behavior. *Psychology of Addictive Behaviors*, 23(2), 348.

Zeman, J., Klimes-Dougan, B., Cassano, M., & Adrian, M. (2007). Measurement issues in emotion research with children and adolescents. *Clinical Psychology: Science and Practice*, 14(4), 377.

Table 1.*Descriptive Statistics for the Adolescent and Adult Samples*

	Child (N=367)	Adult (N=708)
Age		
Mean (SD)	11.1 (3.20)	42.9 (14.5)
Median [Min, Max]	11.0 [6.00, 17.0]	45.0 [18.0, 71.0]
Sex		
Male	200 (54.5%)	315 (44.5%)
Female	167 (45.5%)	392 (55.4%)
Missing	0 (0%)	1 (0.1%)
Ethnicity		
Non-Hispanic/Latinx	295 (80.4%)	605 (85.5%)
Hispanic/Latinx	72 (19.6%)	103 (14.5%)
Race		
White	243 (66.2%)	507 (71.6%)
American Indian/Native Alaskan	5 (1.4%)	7 (1.0%)
Asian	25 (6.8%)	46 (6.5%)
Black/African American	78 (21.3%)	125 (17.7%)
Native Hawaiian/Pacific Islander	2 (0.5%)	3 (0.4%)
Other	14 (3.8%)	19 (2.7%)
Missing	0 (0%)	1 (0.1%)
Activation Control		
Mean (SD)	3.01 (0.856)	5.04 (0.908)
Median [Min, Max]	3.00 [1.14, 4.86]	5.14 [2.00, 7.00]
Missing	136 (37.1%)	3 (0.4%)
Inhibitory Control		
Mean (SD)	3.71 (0.647)	4.71 (0.857)
Median [Min, Max]	3.60 [1.80, 5.00]	4.71 [2.14, 7.00]
Missing	136 (37.1%)	3 (0.4%)
Internalizing T-Score		
Mean (SD)	50.5 (10.8)	48.7 (11.1)
Median [Min, Max]	50.0 [33.0, 85.0]	48.0 [30.0, 82.0]
Externalizing T-Score		

	Child (N=367)	Adult (N=708)
Mean (SD)	48.3 (10.7)	48.0 (9.64)
Median [Min, Max]	48.0 [33.0, 75.0]	48.0 [30.0, 84.0]
Positive Affect		
Mean (SD)	3.30 (0.671)	3.91 (0.998)
Median [Min, Max]	3.33 [1.56, 4.89]	3.86 [1.14, 7.00]
Missing	136 (37.1%)	3 (0.4%)
Negative Affect		
Mean (SD)	2.43 (0.630)	3.67 (0.727)
Median [Min, Max]	2.44 [1.12, 4.31]	3.69 [1.77, 6.00]
Missing	136 (37.1%)	3 (0.4%)
Diagnosis		
No Diagnosis	138 (37.6%)	347 (49.0%)
Internalizing Dx	125 (34.1%)	127 (17.9%)
Externalizing Dx	101 (27.5%)	234 (33.1%)
Missing	3 (0.8%)	0 (0%)
Number of Diagnoses		
Mean (SD)	0.962 (1.04)	1.03 (1.36)
Median [Min, Max]	1.00 [0, 5.00]	1.00 [0, 7.00]

Figure 1

Zero-order Correlations of Adolescent and Adult Samples

Note. NegAff = ATQ/EATQ-R Negative Affect; PosAff= ATQ/EATQ-R Positive Affect; Activation = ATQ/EATQ-R Activation Control; Attention = ATQ/EATQ-R Attentional Control; Inhibition = ATQ/EATQ-R Inhibitory Control; INTL_T = CBCL/ASR Internalizing T-Score; EXTL_T = CBCL/ASR Externalizing T-Score. Significant correlations are in color with strength of effect indicated by the color bar.

Figure 2

Structural Equation Model for Adolescent Model

Note. For Direct Paths: Significant effects are represented with solid bold lines. Non-significant paths are indicated in dashed lines in figure of direct paths. Standardized estimates are provided with standard errors and significance values * $p < .05$ ** $p < .01$ *** $p < .001$. For Indirect Paths: Significant effects are represented with solid bold lines. Standardized estimates are provided with standard errors and p values. Na.Act.Int = indirect path from negative affect to activation control to internalizing; Na.Act.Ex = indirect path from negative affect to activation control to externalizing. Na.Inh.Ex = indirect path from negative affect to inhibitory control to externalizing. Note that all paths were modeled simultaneously but are displayed separately for clarity.

Figure 3

Structural Equation Model for Adult Sample

Note. For Direct Paths: Significant effects are represented with solid bold lines. Non-significant paths are indicated in dashed lines in figure of direct paths. Standardized estimates are provided with standard errors and significance values * $p < .05$ ** $p < .01$ *** $p < .001$. For Indirect Paths: Significant effects are represented with solid bold lines. Standardized estimates are provided with standard errors and p values. Na.Act.Int = indirect path from negative affect to activation control to internalizing; Na.Act.Ex =

indirect path from negative affect to activation control to externalizing. Na.Inh.Ex = indirect path from negative affect to inhibitory control to externalizing. Note that all paths were modeled simultaneously but are displayed separately for clarity.