Negative Affect Associations with Adolescent Psychopathology and Substance Use

by

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Dedication

For Laraine Freund, you are a huge part of who I am and everything I do, including this, and all things to come.

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"Grad school is suffering" – D. Freund

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Abstract

Adolescence and the transition to adulthood are critical periods of development during which to intervene upon problematic behavior and emerging psychopathology. Drawing heavily from developmental psychology perspectives, this dissertation's overarching aim was to better understand the role of internalizing psychopathology in substances use during adolescence.

Utilizing a transdiagnostic, dimensional approach, negative affect was examined across three studies. In the first study, the measurement and structure of the negative affect (NA) construct was assessed using original data collected online via Qualtrics. Negative affect items from the Monitoring the Future (MTF) and the Adolescent Brain and Cognitive Development (ABCD) studies were validated against longer, well-established scales using item response theory (IRT). Next, the structure of NA was assessed using exploratory structural equation modeling (ESEM). The findings provide evidence of convergent validity for the MTF and ABCD NA items thus reducing measurement validity concerns commonly associated with survey data and allowing allow for a synthesis of findings between studies. Structurally, ESEM models fit the NA data best and subfacets of NA displayed unique associations across psychopathology related constructs.

In the second study, levels of NA and impulsivity were used to predict patterns of comorbidity in the first waves of the ABCD dataset. Findings from multinomial logistic regression revealed that, compared to those with no mental health condition (MHC), high levels of anxiety and anger predicted internalizing (IO) and externalizing (EO) diagnoses, respectively. Heterotypic comorbidity was predicted by higher levels of both anxiety and anger. Lack of

perseverance was the only impulsivity construct to consistently predict membership in one of the three mental health diagnosis categories when compared to the no MHC condition. Next, resting state neuroimaging data was used to examine neural correlates of impulsivity in the pre-adolescent brain using Brain Base Set (BBS) modeling. Findings revealed no unique neural networks that were associated with impulsivity. Instead, the associations were weak, and widespread throughout the brain.

The third study used MTF data from 8th, 10th, and 12th grade students to identify unique patterns of NA. Using latent profile analysis (LPA), 5 NA profiles defined by levels of anger, anxiety, boredom, depressive affect, and anhedonia, emerged; low negative affect, moderate negative affect, high negative affect, high positive and negative affect, and emotionally numb. The model was then validated in an independent sample from Study 1. Profile membership was predicted by a number of covariates including school achievement and misbehavior, social interaction, and substance use. Additional tests revealed significant gender moderation.

Findings across studies are synthesized and implications are discussed. Together, the current studies make a number of unique contributions to the literature including 1) providing an in-depth psychometric analysis of survey items related to transdiagnostic indicators 2) establishing convergent validity across negative affect measures included in the MTF and ABCD datasets 3) exploring the combination of impulsivity and NA in heterotypic comorbidity 4) addressing the convergent and divergent hypotheses of NA and 5) examining gender moderation in psychopathology. Together, by providing some clarity regarding construct validity, heterotypic comorbidity and, gender moderation, the findings presented here may contribute to more efficient and tailored efforts to prevent and intervene upon at-risk youth during adolescence.

Chapter 1 Introduction

The study of developmental psychopathology focuses on the emergence and progression of psychopathology throughout the life span. The field places emphasis on interdisciplinary, multilevel research with a focus on the complex interactions that lead to various functional outcomes. By identifying these pathways, the prevention and treatment of psychiatric disorders are better understood and improved (Cicchetti, 2023). Using this perspective, three separate studies related to the development, moderation, and underlying trait structures of psychopathology during adolescence are presented. The first addresses measurement issues by validating widely used scales and survey measures capturing psychopathological constructs. The second examines issues of comorbidity and transdiagnostic indicators (impulsivity and negative affect) at the symptom and neurological levels. Finally, the third takes a combined person- and variable-centered approach to examine categorically distinct combinations of negative affect in the prediction of substance use during adolescence. Together, the studies contribute much needed evidence of construct validity, examine psychopathology at multiple levels, provide an in-depth examination of transdiagnostic indicators and complex interactions, and aim to provide clarity regarding psychopathological substrates during adolescence.

Adolescence & The Transition to Adulthood

Classic views on development originally suggested that growth was essentially complete by the time an individual reached adolescence (Piaget et al., 1969). However, in the decades since, research has revealed that, during adolescence, a multitude of overlapping biological and

environmental changes take place (Casey et al., 2008). This results in a period of profound growth and development occurring on multiple levels. Adolescence begins with puberty; a cascade of hormonal processes, that influence body and behavior (Forbes & Dahl, 2010). Additionally, several structures in the brain mature and increased pruning and myelination leads to stronger, more efficient functional connections between brain regions (Casey et al., 2008). At the environmental level, social relationships begin to take priority and peer influence becomes more prominent. Adolescence is further characterized by a need for independence, a focus on identity formation, and increasing risk-taking behaviors (Steinberg, 2008).

After adolescence, it is useful to distinguish the transition to adulthood (typically covering from age 18 up through the early 20s) from early adulthood (typically covering the mid-20s through early 30s). Similar to adolescence, the transition to adulthood is a stage during which new social roles emerge, brain maturation continues, and individuals' life paths further diversify (Hare et al., 2008; Schulenberg et al., 2004). For some, this transition period provides opportunities for growth and freedom from difficulties experienced during adolescence. For others, it is yet another pivotal transition period during which one is at high risk for a number of undesirable outcomes, including consequences linked to psychopathology (Moffitt & Caspi, 2001; Schulenberg et al., 2004). For example, studies show that the link between negative affect and substance use strengthens during the transition to young adulthood and into adulthood proper (e.g., Freund & Schulenberg, 2023). Likewise, symptoms of psychopathology often increase and solidify in severity during this period (Hopwood et al., 2022; Schulenberg et al., 2004).

The dynamic nature of these developmental periods makes it a time during which one's life trajectory can pivot drastically, for better or worse. As such, both are characterized by

heightened risk and are critical stages during which to intervene on problematic behavior and emerging psychopathology (Cicchetti, 2023).

The Structure of Psychopathology

Several studies have confirmed the hierarchical nature of psychopathology with an overarching factor, "p", representing one's level of or risk of developing psychopathology of any kind (Caspi & Moffitt, 2018). Higher scores on the "p" factor has been shown to be associated with worse academic, criminal, social, and health related outcomes (Sallis et al., 2019; Skodol & Bender, 2008). This general factor can then be split into two domains: internalizing and externalizing. Externalizing disorders encompass a pattern of behaviors that are deviant, disruptive, or anti-social in nature (Beauchaine, 2015; Beauchaine et al., 2017). The most benign of which being attention deficit hyperactive disorder (ADHD). Other, more severe forms of externalizing psychopathology include diagnoses such as conduct disorder (CD) and anti-social personality disorder (ASPD). Internalizing disorders are characterized by negative emotionality and withdrawal from one's environment. They include major depressive disorder (MDD), and numerous anxiety disorders (e.g., panic disorder, social anxiety disorder, generalized anxiety disorder; Hankin et al., 2016; Kotov et al., 2017).

Psychopathology in Adolescence & Young Adulthood

Starting with the onset of puberty, adolescence marks the beginning of rapid and pervasive brain maturation and includes a shift in focus towards peers and socializing, identity formation, exploration, and risk taking (Steinberg, 2008). It is also during this time that psychopathological symptoms and behaviors begin to emerge. The development of psychopathology is thought to be due to complex interactions between genetic predispositions and numerous environmental factors (Cicchetti, 2023). Given an immature brain structure,

adolescence is suggested to be a period of heightened vulnerability to these risk factors (Steinberg, 2010). In fact, a majority of adults with a mental health diagnosis report an initial age of onset prior to 15 years old (Kim-Cohen et al., 2003), with several disorders emerging or peaking in severity during adolescence (Skodol & Bender, 2008). Additionally, juvenile age of onset and symptom severity during adolescence are associated with poor health and social outcomes in young adulthood and a worse prognosis overall (Skodol & Bender, 2008).

It is during adolescence and the transition to adulthood that experimentation with substance use begins . While substance use is normative at these ages, it can also lead to several adverse outcomes including having negative effects on brain development and addiction (Schulenberg et al., 2019). Substance use rates are higher in adolescence and young adults with psychopathology which may, in some cases, suggest a self-medicating/coping motivation for use (Grant et al., 2009; McCauley Ohannessian, 2014; Welsh et al., 2017). Alternatively, weak emotional regulation skills, characteristic of psychopathology, may make adolescents and young adults more likely to use maladaptive means, such as intoxication, to regulate their emotions (Beauchaine, 2015; Hussong et al., 2011). Studies have shown that coping motivations for substance use predicts numerous and more severe negative consequences both concurrently and longitudinally (Anker & Kushner, 2019; Gillen et al., 2016). As such, the link between psychopathology and substance use at these ages warrants particular attention.

Psychopathology and Substance Use

Despite decades of research, the relationship between externalizing and internalizing disorders and alcohol and drug use in adolescence is still unclear (Behrendt et al., 2017; Eaton et al., 2015). Previous studies have identified strong correlations between externalizing symptoms and alcohol and drug use in adolescence (Dawson et al., 2010) However, the externalizing

pathway to substance use and abuse is not endemic; one study found that externalizing pathways only account for an estimated 28% of those identified as having a substance use disorder (Grant et al., 2010), highlighting the heterogeneity of psychopathology- substance use pathways. There is considerable controversy in the literature regarding the role of internalizing pathways in adolescent substance use (Hussong et al., 2011). For example, some studies have found that depression lowers the risk of substance use (Kaplow et al., 2001), some that substance use contributes to depression (Beal et al., 2014), others have found no effect of depression on substance use (Zucker, 2015), and still others have found symptoms of depression and anxiety to be predictive of greater substance use, especially for females (Sung et al., 2004).

Understanding the internalizing pathway to substance use is becoming more and more important as recent national survey data shows that rates of depressive affect are increasing in U.S. adolescents (Keyes et al., 2019). Additional studies have shown that high levels of externalizing and internalizing symptoms combined are more strongly associated with substance use than they are on their own (Mahendran et al., 2021; Maslowsky & Schulenberg, 2013; Maslowsky et al., 2014). These findings suggest that comorbidity across disorders is a risk factor for substance use but may also suggest that levels of an underlying component, common across disorders, may be more useful for understanding the psychopathology-substance use association.

Transdiagnostic Indicators

Conceptualizing psychopathology as categorical in nature is limiting and may be partly to blame for conflicting findings in the literature. Kotov et al. (2017) points out that the taxonomies that have been imposed on psychopathology have unclear boundaries and were done so without sufficient consideration for the heterogeneity within. As such, the authors suggest an alternative hierarchical taxonomy of psychopathology that not only restructures the conceptual

understanding of disorders, but includes related traits that act as indicators of disorder as well. It is these trait indicators that may provide clarity in the relationship between psychopathology and substance use.

Current findings in the literature support a shift in focus from categorical definitions to those that view psychopathology as a combination of dysfunctional underlying processes (Hankin et al., 2016). For example, findings show that it is the shared variance between internalizing and externalizing disorders that is most important for understanding long term psychopathology outcomes (Sallis et al., 2019). Relatedly, research on the structure and overlap between mental disorders indicates that psychopathology and substance use can be explained by a handful of latent traits called transdiagnostic indicators (Eaton et al., 2015). Transdiagnostic indicators are continuous latent variables, or traits, that have been shown to be relatively stable over time (Hankin et al., 2016). These indicators are especially valuable for examining continuity, comorbidity, and the nuances of mental disorders, in general (Eaton et al., 2015).

Transdiagnostic indicators can take many forms such as biological (e.g., HPA-axis sensitivity), or personality related (i.e. traits). In the literature, various terms are used, but most generally they are referred to as a type of "trait" (e.g., maladaptive traits, trait indicators, transdiagnostic traits, etc.; Kotov et al., 2017). Two such traits are negative affect, the tendency to experience negative emotional states, and impulsivity, acting without forethought towards consequences of one's actions. Negative affect is considered a core feature of internalizing disorders while impulsivity is most often linked to externalizing behaviors (Beauchaine et al., 2018). However, both have associations with disorders across the internalizing-externalizing spectrum (Hankin et al., 2016). For example, impulsivity is indicated in depression and suicide attempts (Ortin et al., 2012), and negative affect is associated with aggression and addictive

behaviors (Stanton & Watson, 2014). Furthermore, negative affect and impulsivity have both been shown to be associated with substance use during adolescence (Forbes et al., 2016; Freund et al., 2021).

Gender Differences

The number of complex interactions in developmental psychopathology that span multiple levels of analysis make it impossible to examine all potential moderators at once. Of particular interest in psychopathology is the issue of gender moderation. This is due to the consistent gendered disparities in the prevalence of psychopathology diagnoses, related behaviors and traits, and treatment outcomes reported in the literature (Hartung & Lefler, 2019). For example, females reported higher levels of negative affect, anxiety disorders, and better treatment outcomes (Lijster et al., 2017; Nolen-Hoeksema, 2012; Sharf & Primavera, 2009), while males report higher levels of impulsivity, substance use, and externalizing disorders (Eaton et al., 2012a; Farmer et al., 2013; Rapee et al., 2019).

Despite a recent increase in the number of studies incorporating more gender representative samples, gender moderation is rarely looked at directly in psychopathology (Hartung & Lefler, 2019). Furthermore, the mechanisms behind gender differences that do appear in the psychopathology literature are still not fully understood. Differences in psychopathology outcomes and prevalence rates across gender have been suggested to stem from biological influences (e.g. hormones), environmental influences (e.g. gendered socialization), or a combination of the two. Alternatively, methodological errors have also been implicated such as sampling and referral bias (Hartung & Lefler, 2019).

By ignoring differences across gender, etiological models of psychopathology are incomplete and potentially misleading. This inhibits identification and prevention efforts. For

example, some evidence shows that conduct problems in childhood are a risk factor for future depression in boys, but not girls (Greimel et al., 2022). Advancements in psychopathological assessment and treatment are also hindered by taking a gender neutral approach.

Measurement Issues

There is inconsistency in how psychopathology constructs are operationalized which creates uncertainty when trying to compare findings across studies. The term "negative affect", for example, has been used to describe individual facets of negative affect (anxiety, depression, anger), a lack of positive affect, or some combination therein (Bravo et al., 2020). This is concerning given that research shows that high negative affect (NA) is *not* the same as low positive affect, and that negative affect dimensions, while related, have unique associations with outcomes (Lan et al., 2021; Stanton & Watson, 2014). Psychometric research is needed to understand these constructs more deeply so that definitions can be more precise and applied consistently.

Additional measurement issues may also be to blame for conflicting findings in the literature. It is not often that items from scales measuring the same construct are compared to ensure that scale scores have the same meaning. Thus, one's ability to consolidate findings across studies is limited. For example, many scales purportedly measuring anxiety have actually been shown to capture levels of depression as well, and vice versa (Renner et al., 2018). It is only through psychometric analyses that more precise measures of depression and anxiety have begun to emerge (e.g., Renner et al., 2018). Relatedly, large survey datasets often have limited space and thus use modified items or shortened scales that have not been tested for validity. Finally, when studies do use well-established and validated measures, differential item functioning (DIF) is rarely examined which leads to biased results; this is especially important when comparing

subgroups of participants, such as when examining gender moderation (Hartung & Lefler, 2019; Meitinger et al., 2020).

The Current Studies

This dissertation integrates three studies using a developmental psychopathology approach to study transdiagnostic indicators of psychopathology during adolescence and the transition to adulthood, and address issues related to measurement and gender differences. Original data as well as the Monitoring the Future (MTF) and Adolescent Brain and Cognitive Development (ABCD) datasets are used. MTF is a NIDA funded, U.S. national study, that aims to track changes in lifestyles, values, and behaviors of youth and adults in the United States with a focus on the prevalence, risk factors, consequences, and patterns of substance use in adolescence and adulthood (Miech et al., 2022; Schulenberg et al., 2021). The MTF cross-sectional study of teens utilizes a cohort-sequential design, collecting cross-sectional data from approximately 415 public and private schools, every year, using in-school surveys (Bachman et al., 2015). ABCD is a U.S. longitudinal, multisite study that includes a comprehensive set of assessments covering physical health, cognition, social functioning, emotional development, environmental influences, behaviors, and academics. It further includes neuroimaging, hormonal, and genetic data (Jernigan et al., 2018). A total of 11,878 Participants were recruited for baseline data collection at the ages of 9 to 10 years old with data collected yearly until they reach the age of 19 to 20 years old. Currently, 2 batches of data have been released that include the full baseline sample (Compton et al., 2019).

The first study, presented in Chapter 2, consists of in-depth psychometric analyses to establish the validity of trait measures related to psychopathology and substance use that are included in the MTF and ABCD datasets. Using original data collected from a national sample of

18-30 year-olds, these survey items were validated against well established and widely used scales using item response theory (IRT). Additionally, differential item functioning (DIF) was tested. The second set of analyses uses exploratory structural equation modeling (ESEM) to better understand the uniqueness (or lack thereof) of negative affect dimensions. The results of this study allow for a better understanding of the validity of the measures used in MTF and ABCD and the construct of negative affect more generally. Furthermore, the findings guided construct selection in studies 2 and 3 and will allow for a more informed comparison of results from future studies using these datasets.

The second study, presented in Chapter 3, uses the ABCD US national dataset to examine negative affect predictors of psychopathology and the neural correlates of impulsivity in pre-adolescence (age 10). Identifying risk factors at this age, just prior to the average age of substance use initiation (Miech et al., 2022), would lay the groundwork for future studies to examine causal relationships between substance use and transdiagnostic indicators, at the neurological and self-report level, over time. In the study, teacher and youth reported levels of anger, depressive affect, and anxiety were used to predict membership in one of 4 mental health categories: no mental health diagnoses, internalizing disorder(s) only, externalizing disorder(s) only, or heterotypic comorbidity (both internalizing and externalizing diagnoses). The findings allow for better insight into how mental health manifests emotionally prior to adolescence and how the emotional makeup of those with heterotypic comorbidity differs from those with just one type of psychopathology (internalizing or externalizing). Secondly, a more in-depth look at the neural correlates of the impulsivity sub-facets of positive and negative urgency, lack of premeditation, and lack of perseverance were tested. These analyses provide a more in-depth

look at another important transdiagnostic indicator and its ability to be detected in the brain prior to the average age of onset for multiple psychopathologies.

The third study, presented in Chapter 4, uses MTF data to take a unique look at negative affect in adolescence (in US nationally representative samples of 8th, 10th, and 12th graders). Broken down into 5 facets, anhedonia, depression, anxiety, boredom and anger, negative affect levels were used to construct latent profiles in a nationally representative adolescent sample. The model was validated using the sample from study 1 and substance use was then used to predict profile membership. Finally, the model was tested for gender moderation. The measures used in this study were chosen based on the findings from study 1. Like study 1, the analyses aim to address issues surrounding the conceptualization and definition of negative affect. Further, the analyses test the hypothesis that qualitatively different substrates of negative affect may exist that, in turn, differentially predict associations with substance use in adolescence. Finally, similar to study 2 gender moderation is examined. First, gender is used to predict latent profile membership and then the final models are tested for gender moderation.

Together, the studies are connected by the use of a multilevel, dimensional approach that is a core component of developmental psychopathology research. Transdiagnostic indicators are used instead of diagnoses to examine issues related to psychopathology and substance use. This allows for a deeper understanding of the underlying mechanisms driving the development of psychopathology. More specifically, study 1 addresses issues related to the measurement and conceptualization of negative affect. It validates the measures used in studies 2 and 3 and tests for differential item functioning to ensure unbiased gender comparisons in subsequent analyses. Study 2 addresses how issues of comorbidity may be explained by the combination of impulsivity and NA facets, with a focus on the poorly understood phenomenon of heterotypic

comorbidity. Study 2 further incorporates neurological data to test for neural correlates of individual facets of impulsivity in the preadolescent brain. Finally, study 3 uses an older adolescent sample to better understand the underlying components of negative affect and how NA profiles are associated with substance use. Gender moderation is tested in both studies 2 and 3 to ensure a more complete picture is obtained. The final chapter, Chapter 5, consists of a synthesis of the results found across studies, addresses issues that arose, and discusses broader implications and future directions for the study of transdiagnostic indicators and adolescent mental health and substance use.

Chapter 2 The Structure and Measurement of Negative Affect

During adolescence and young adulthood, both internalizing and externalizing disorders emerge and intensify along with an increase in risk-taking behaviors, including substance use (Castellanos-Ryan et al., 2016). Although studies consistently show strong associations between substance use and externalizing disorders, there is still considerable controversy in the literature regarding the role of internalizing pathways in adolescent substance use (Hussong et al., 2011). For example, some studies have found that depression lowers the risk of substance use (e.g., Kaplow et al., 2001), some have found that substance use contributes to depression (e.g., Beal et al., 2014), others have found no effect of depression on substance use (e.g., Hussong et al., 2017), and still others have found symptoms of depression and anxiety to be predictive of greater substance use, especially for females (e.g., Sung et al., 2004). Methodological issues, however, such as using small, non-representative samples, and lack of clarity and consistency regarding the definition and measurement of constructs, makes it difficult to compare findings across studies. The current study takes an in-depth look at the psychometric properties of negative affect measures in a sample of late adolescents and young adults (ages 18 to 30). The overarching goal of these analyses is to facilitate subsequent research on internalizing symptomology using nationally representative data of adolescence and young adults in the Monitoring the Future (MTF; Schulenberg et al., 2021) and Adolescent Brain and Cognitive Development (ABCD; Jernigan et al., 2018) datasets. The following review of the literature will cover existing research on the link between NA and psychopathology, as well as theories, definitions, and measurement issues related to negative affect.

The Study of Psychopathology and Development

Developmental psychopathology uses a multidisciplinary approach to chart the development of psychopathology over the lifespan. The field is focused on complex, multi-level interactions and issues of heterogeneity, continuity, multifinality and equifinality (Cicchetti, 2023). Given the complex nature of psychopathology models, large, longitudinal, and representative datasets with valid measures of symptomology are vital. Two current and prominent resources include the Adolescent Brain and Cognitive Development Study (ABCD; Jernigan et al., 2018) and the Monitoring the Future study (MTF; Schulenberg et al., 2021).

ABCD is a longitudinal multisite study with a number of assessments related to cognition, health, social functioning, cognition, behavior and environmental influences as well as genetic, hormonal, and neuroimaging data (Jernigan et al., 2018). The sample consists of 11,878 nine to ten year-old participants, followed for 10 years, making it the largest U.S. study on brain development that incorporates longitudinal and neuroimaging measures (Karcher & Barch, 2021). Initial recruitment ended in 2018 and data collection is still in process (Alcohol Research: Current Reviews Editorial Staff, 2018).

MTF is a NIDA funded, U.S. national study, that aims to track changes in the lifestyles and behaviors of youth and adults in the United States with a focus on patterns of substance use (Miech et al., 2019; Miech et al., 2021; Schulenberg et al., 2021). Every year, MTF collects data from 8th, 10th and 12th grade students from approximately 415 public and private schools using in-school surveys (Bachman et al., 2015). The study also includes follow-up data collected biennially from approximately 2,500 individuals selected each year from the 12th grade participants.

Each dataset provides access to researchers for secondary data analysis and the modeling of complex associations related to development and psychopathology. As such, it is important to empirically test the validity of the items included. MTF and ABCD overlap on a handful of NA constructs including anger, depression, and anxiety. By establishing the convergent validity of these items, conclusions drawn from studies using these datasets are strengthened and the consolidation of results across datasets is possible.

Negative Affect

Internalizing pathways to substance use are defined by negative emotionality, or trait negative affect, which is suggested to be due to deficits in emotion regulation (Hussong et al., 2011). Negative affect (NA) is an underlying trait that, although associated with both internalizing and externalizing symptoms, is considered the core feature of the internalizing domain of psychopathology (Forbes et al., 2016). NA refers, specifically, to the predisposition towards experiencing aversive affective states (Hankin et al., 2016). Evidence suggests that NA is multifaceted, with the exact facets varying depending on the measures used (Stanton & Watson, 2014). In general, NA is found to consist of three facets: sadness/guilt, fear/anxiety, and anger/irritability (hence forth referred to as depression, anxiety, and anger, respectively). Literature on individual facets of NA are limited, but generally indicate that sadness and guilt are associated with depression, while fear and anxiety are linked to both anxiety and depressive disorders (Watson et al., 2011). The anger/irritability factor demonstrates weaker associations with internalizing disorders and may partly explain the association between NA and externalizing behavior (Stanton & Watson, 2014). Still, the associations between specific aspects of NA and manifestations of psychopathology, including substance use, is understudied and requires further investigation.

The most commonly studied aspects of NA, in relation to substance use, are anxiety and depression, with the literature showing mixed results, especially in adolescent samples. In studies that do find a significant association, the majority indicate a positive relationship between internalizing symptoms and substance use (e.g., Maslowsky et al., 2014). Still, many find negative or nonsignificant associations, especially after controlling for externalizing behaviors (Hussong et al., 2017). These discrepancies may be due to several factors, including issues related to measurement.

Measuring Negative Affect

Measures of internalizing symptoms and NA are heterogeneous and broad. For example, studies use NA as a term synonymous with depression, anxiety, anger, stress, or any combination therein (Bravo et al., 2020 ; Hussong et al., 2017; Stanton & Watson, 2014; Thomsen et al., 2005) or as a higher order factor encompassing all negative emotions (Malesza, 2019; Watson et al., 1988). Furthermore, despite evidence to the contrary (Lan et al., 2021; Naragon & Watson, 2009; Watson et al., 1999), low positive affect is sometimes used interchangeably with high NA (Moors et al., 2021). Even if studies in the literature used more consistent definitions of NA, the existence of so many scales, and a lack of research on their psychometric properties, makes it impossible to rule out measurement bias as a primary source of the mixed findings in the literature.

Factor Structure

Relatedly, there is no consensus regarding the factor structure or theoretical relationship between individual facets of NA. The convergent hypothesis posits that the nomological network between anger, anxiety, and depression is the same, whereas the divergent hypothesis posits that the nomological network of these constructs are distinct (Katon & Roy-Byrne, 1991; Watson &

Tellegen, 1985). Arguments for the former suggest that, while unique, these emotions each influence one another to a great degree and, as such, one can very quickly and easily transition from one negative emotional state to another. Thus, these emotions overlap to such a great degree that spillover and reciprocal exacerbation occur. Additionally, it is suggested that each emotion stems from an underlying general NA factor that is experienced as anger, anxiety, or depression based on environmental and situational influences (Diener et al., 1995).

The divergent hypothesis argues that the proximal precursors for each emotion are distinct, and, that the experience of one versus another can be seen in the varying levels of activation and arousal (Barclay et al., 2005; Roseman et al., 1994). Depression, for example, is characterized by very low levels of arousal, while anger and anxiety are both characterized by high levels of arousal. In the current study, tests of convergent and divergent validity for the NA measures of anger, anxiety, depression, and boredom allow for an exploration of the convergent and divergent theories of emotion. Specifically, associations within NA dimensions and across the related constructs of behavioral inhibition/activation, emotional regulation, positive affect, aggression, and impulsivity, are examined. Similar patterns of correlation would support the convergent hypothesis, while differing patterns of association would support the divergent hypothesis.

Construct Validity

Validity and reliability are related but distinct characteristics of a measure. Validity refers to accurately measuring a construct while reliability refers to precise measurements that are replicable over time. Good construct validity is necessary but not sufficient for establishing good reliability (Kline, 2005). The aim of the current study is to examine validity specifically. That is,

are survey items accurately measuring the constructs they are suggested to measure? Furthermore, are items across large survey datasets truly capturing the same construct?

Further complicating the issue of negative affect measurement, and psychological constructs in general, the validity of a measure may change by cultural background, gender, or any number of demographic characteristics of a sample, thus making claims about group differences uninterpretable (Meitinger et al., 2020). Still, many widely-used measures have not been adequately validated and group invariance is rarely tested (Beauchaine et al., 2018; Curran & Willoughby, 2003; Kotelnikova et al., 2016). Despite this, conclusions and recommendations based on group comparisons continue to be made in the psychological literature. For example, a demographic characteristic that is highly relevant in psychopathology is gender (Hartung & Lefler, 2019). It is well established that gender differences exist not only in the prevalence of psychological disorders, but in levels of underlying traits such as negative affect (Eaton et al., 2012a; Hartung & Lefler, 2019; Nolen-Hoeksema, 2012; Rapee et al., 2019). Yet, the reasons for these gender differences are still not understood and gender biased measurements have yet to be ruled out as a cause (Hartung & Lefler, 2019). Until issues of measurement validity and bias are fully addressed, identification, prevention, and treatment efforts for psychopathology are limited and incomplete, at best. Furthermore, it is likely that discrepancies in the literature will continue to propagate, especially regarding internalizing disorders and substance use.

Individual Facets of Negative Affect and Associated Constructs

Anger, anxiety, and depression are the most commonly studied and accepted facets of NA. Anger is an emotional response to an environmental stimulus that is perceived as threatening or blocking one's advancement towards a goal (Dollar & Calkins, 2019). Trait anger refers to a tendency to be easily angered or irritable and is linked to outbursts and aggressive acts

(Perry & Ostrov, 2018). Anxiety is also a high arousal state characterized by excessive worry (Barlow, 2004), while depression is a low arousal state characterized by feelings of sadness and loss of motivation (Rosenstrom & Jokela, 2017). The two are consistently found to be highly correlated with one another, and comorbidity in clinical populations is very common (Cummings et al., 2014). One reason for this may be that items measuring depression are not unidimensional; that is, the items capture aspects of both constructs. As such, the measure of anxiety chosen for the current study (the STADI ; Renner et al., 2018) was specifically designed to avoid cross contamination between anxiety and depression.

Boredom

Boredom as a construct has gained increasing attention over the past decade. Boredom is defined as an unpleasant state in which one's need for stimulation are not being met (Raffaelli et al., 2017). Boredom is often viewed as a symptom of depression and studies find that the two are highly correlated. Recent research, however, demonstrates that boredom is a distinct emotional state that can be accompanied by either high or low arousal (Dahlen et al., 2004; Mercer-Lynn et al., 2011; Vodanovich & Watt, 2016). Boredom is also found in the sensation seeking literature. Sensation seeking refers to the need for high levels of stimulation and boredom sensitivity is included as a subscale on the well-establish Sensation Seeking Scale (SSS; Zuckerman et al., 1964). As with depression, recent research has shown that boredom is associated with sensation seeking, but represents a unique construct (Freund et al., 2021).

As interest in boredom as a unique construct is still relatively new, there is not much in the literature linking boredom to negative affect or psychopathology, beyond its association with depression, and as a motivation for substance use (Patrick et al., 2011).. Recent studies have shown that the experience of boredom is prominent and associated with a number of undesirable

outcomes during adolescence (Martz et al., 2018), including symptoms of psychopathology (Freund et al., 2021). Given boredom's strong associations with depression (Vodanovich & Watt, 2016), and the ability for it to occur with high arousal (as does anxiety and anger), boredom was included in the current study and treated as a facet of NA. As boredom is not typically viewed as a form of NA, its inclusion in the current study is exploratory. However, it is predicted to be highly related to the other NA states of anxiety, anger, and depression.

Anhedonia

The DSM-V lists anhedonia (i.e. loss of interest and inability to experience pleasure) as a core feature of depression (American Psychiatric Association & DSM Task Force, 2013). It is associated with more severe forms of depression, sometimes called melancholic depression (De Fruyt et al., 2020). In melancholic depression, both anticipatory and consummatory reward processing is impaired. In other words, individuals don't anticipate positive reactions to rewards, nor do they experience them when they encounter positive stimuli (Shankman et al., 2014; Zisner & Beauchaine, 2016). Importantly, while studies consistently find depression and anxiety to be highly related, anhedonia is suggested to be the symptom that distinguishes depression from anxiety (Watson et al., 2011).

Behavioral Inhibition and Behavioral Activation Systems

The tendency to experience one form of negative affect versus another is suggested to depend, in part, on behavioral motivation systems in the brain (Beauchaine & Tackett, 2020; Beauchaine & Zisner, 2017; Zisner & Beauchaine, 2016). The Behavioral Activation System (BAS) and Behavioral Inhibition System (BIS) refer to two neural motivational systems that control approach and avoidance responses to possible rewards, conflict, and threat (Gray, 1990). Sensitivity of the BIS system, or sensitivity to punishment, results in avoidance behaviors, and is

linked to both depression and anxiety. Low levels of BIS sensitivity is associated with impulsivity (Carver & White, 1994) and higher sensitivity to the BAS system is associated with approach behavior, anger, and externalizing disorders (Beauchaine & Zisner, 2017).

Emotion Regulation

Self-regulation of emotion is suggested to be a key underlying factor that contributes to the experience of negative affect and psychopathology (Beauchaine & Cicchetti, 2019). Internalizing disorders involve dysregulated levels of avoidant or withdrawn related affect such as sadness and fear while externalizing disorders involve dysregulated levels of approach related emotional states such as anger (Beauchaine, 2015). Emotion regulation (ER), specifically, refers to the ability to identify, accept, and moderate one's emotional states via either adaptive or maladaptive strategies (McRae & Gross, 2020). Acknowledgement and understanding of one's emotions and the implementation of positive ER strategies are associated with higher academic achievement (Ivcevic & Brackett, 2014), more satisfying social relationships (English et al., 2012), and greater health and well-being (Appleton et al., 2014; Gross & John, 2003). On the other hand, maladaptive strategies have been implicated in the worsening of psychopathology disorders (Gross & John, 2003), substance use (Kober, 2014), less fulfilling interpersonal relationships (English et al., 2012), and self-injurious behavior (Swerdlow et al., 2020).

Urgency

Positive and negative urgency are two emotion-related facets of impulsivity. The constructs capture the tendency to act impulsively while experiencing extreme emotions, either positive or negative (Cyders & Smith, 2007). Both have been implicated in multiple forms of psychopathology and addictive behaviors (Cyders & Smith, 2008; Johnson et al., 2017; Romer Thomsen et al., 2018). Given the multitude of negative consequences associated with the trait of

urgency, negative urgency in particular (Berg et al., 2015), it is an especially relevant construct to examine when looking at emotional states.

Current Study

The overarching aim of the current study was to establish construct validity for survey items and scales that measure unique dimensions of NA among older adolescents and young adults. The study used original data collected from Qualtrics and can be broken down into four major aims. Firstly, using item response theory (IRT), NA items from widely-used, nationally representative surveys were validated against more commonly used scales of depression, anxiety, boredom, and, anger. Secondly, to address measurement bias, differential item functioning (DIF) was tested across demographic characteristics with a focus on gender. Thirdly, exploratory structural equation modeling (ESEM) was used to test the convergent and divergent theories of negative affect. And finally, using ESEM-within-CFA models, tests of convergent and divergent validity were conducted using the affect related constructs described above. Based on existing literature, a number of specific associations were expected. It was predicted that 1) anger would be strongly, positively associated with aggression, BAS measures, and positive and negative urgency 2) depression and anxiety would be positively associated with BIS and negative urgency 3) anhedonia would be associated with depression, but not anxiety 4) boredom would be positively associated with BAS (fun seeking) and BIS and 5) all NA constructs would be negatively associated with emotional regulation and positive affect.

2.1 Method

2.1.1 Sample

Qualtrics was used to collect participants and administer the online survey. Quotas were specified based on age, sex, gender, race/ethnicity, and income, to resemble U.S. population

parameters for these variables. The final sample had $N = 753$ participants; demographic characteristics are shown in Table 1. The age range of participants covers 18 – 30 years of age with a mean age of $M = 23.9$ years.

2.1.2 Survey Design

To limit the length of survey completion to around 15 minutes, and reduce participant burden, a planned missingness design was implemented. A 3-form design was used (see Table 2). This approach incorporates the matrix sampling concept with the aim of reducing the amount of time it takes to complete a survey by including more questions, total, across the three forms, than could be filled out by an individual (Graham et al., 2006). For the current survey, this was done by altering the number of items presented across forms A, B and C for the constructs of boredom and impulsivity. For boredom, the forms differ regarding which boredom scales are presented; Form A including only the Boredom Proneness Scale (BPS; Farmer & Sundberg, 1986). Form B only the Multidimensional State Boredom Scale (MSBS; Fahlman et al., 2013), and Form C both the BPS and MSBS. All forms include the two MTF boredom items. To alleviate some of the burden from the boredom construct on Form C, a reduced number of impulsivity items were included. Thus, on Form C, the impulsivity measure includes the 7 MTF items, and 3 of the subscales from the SUPPS-P (Cyders et al., 2015): Positive Urgency, Negative Urgency, and Sensation Seeking. Both Forms A and B include the total number of impulsivity items (see Table 2). The survey was administered via Qualtrics. Each block included one construct, with the order of block presentation randomized. Forms A, B, and C were assigned to participants at random.

2.1.3 Measures

The response category options for each item and scale were standardized to range from 1(strongly disagree) to 5 (strongly agree), unless otherwise noted below. Several of the scales included utilize a 0 to 4 scale, in their original form, thus this modification was deemed inconsequential. This change, however, was more noteworthy in the ABCD items, which often utilized a 3-point scale ranging from 0 (not true) to 2 (very true). A list of all included scales is shown in Table 3.

Positive and Negative Affect Schedule – Expanded Form (PANAS)).

Positive and negative affect was measured using a subset of items from the Positive and Negative Affect Schedule – Expanded Form (PANAS; Watson et al., 1988) . The scales demonstrate adequate discriminant and external validity, and stable scores across time with test-retest coefficients ranging from r = .51 to r = .71 (Watson & Clark, 1994). The trait version of the PANAS, used in the current survey, asks to what extent one experiences an affective state, in general. The PANAS can be divided into multiple different subscales based on how one decides to group affective states. A total of 25 items were chosen for the current survey which fall into 5 subcategories: anger/irritability, self-esteem/confidence, anxiety, depression, and positive affect. Items from the PANAS were not analyzed as one set, instead items from each subcategory were included and analyzed with their respective NA construct. The anger items were included on a scale along with items from MTF and ABCD; anxiety and depression items were analyzed with the anxiety and depression measures, respectively, described in detail below. Additionally, 7 PANAS items were used to measure positive affect. These included emotional states such as "happy" and "energetic".

Anger

Three items from the PANAS scale were included in the anger scale: angry, irritable, and hostile. One item from MTF ("I have trouble controlling my temper") and two from ABCD (e.g., "I argue a lot") were also included.

Anxiety

State-Trait Anxiety-Depression Inventory (STADI). The State-Trait Anxiety-Depression Inventory (STADI; Renner et al., 2018) is a recent adaptation of the commonly used State-Trait Anxiety Inventory (STAI; Spielberger, 1983). The STADI trait scores demonstrate good internal consistency across multiple studies and populations (Barnes et al., 2002). Like the STAI, the STADI does not aim to provide clinical diagnoses. Instead, the STADI was constructed with the intent to create items that clearly represented either anxiety or depression by excluding items that included content relevant to both. This led to the creation of emotionality and worry subscales, allowing for both the cognitive and affective aspects of anxiety to be captured in a balanced way. Thus, while far less established when compared to other anxiety scales, in terms of content validity, the STADI was considered superior. Each subscale of the STADI consists of 5 items.

MTF and ABCD Items. MTF recently added two anxiety related items to its survey; "I am often anxious" and "I worry about what other people think of me". Respectively, these items can be conceptualized as capturing emotionality, or, more specifically, the frequency with which one experiences the affective state of anxiety, and the cognitive manifestation of worry, specifically regarding social situations. The items have a reliability of $\alpha = 0.65$ and are present in the 3 most recent cohorts, spanning 2017 to 2019.

ABCD has 3 items that relate to anxiety. As with MTF, they can also be conceptualized as capturing the emotionality (e.g., "I feel too guilty") and worry (e.g., "I worry a lot")

components of anxiety. In the ABCD dataset, the response options for these items ranged from 0 (Not True) to 2 (True). For the current survey, they were included with the modified response options, 1 (Strongly Disagree) to 5(Strongly Agree). Reasons for which are discussed in more detail above.

Boredom

Boredom Proneness Scale (BPS). Boredom proneness is a type of trait boredom most commonly measured by the Boredom Proneness Scale (BPS; Farmer & Sundberg, 1986). This scale conceptualizes boredom as one's ability to interact and connect with their environment. For the current survey, a shortened, 8-item version of the BPS was included.

Multidimensional State Boredom Scale – Trait Version. More recently, the Multidimensional State Boredom Scale (MSBS; Fahlman et al., 2013), was introduced as the first full-scale measure of state boredom, later translated into a trait version (Gerritsen et al., 2014). This scale was built around disengagement being the core feature of boredom. The scale includes five factors that encompass both the core features and the heterogeneity found in the experience of boredom: disengagement, high arousal, low arousal, inattention, and time perception. A higher order factor representing general boredom has also been identified. While the full scale was included on the survey, only the disengagement subscale (9 items) were used for the current analyses.

MTF and ABCD Items. MTF has two items that capture general trait boredom ("I often feel bored"), with an emphasis on disengagement ("I often find I have nothing to do"). These items were created with input from experts in the field and are like those found on the BPS and the disengagement subscale of the MSBS. Boredom items are not present in the ABCD dataset.

Depression

Hospital Anxiety & Depression Scale (HADS). The Hospital Anxiety & Depression Scale (HADS; Snaith & Zigmond, 1986) is designed to measure anxiety and depressive symptoms in the general medical population. It is one of three instruments endorsed by the National Institute for Health as a measure for baseline depression (Smarr & Keefer, 2011). The current survey includes the 7-item HADS depression subscale (HADS-D). The measure has been found to be as effective as more comprehensive measures at screening for depressive symptoms. HADS-D demonstrates high internal consistency (mean $\alpha = 0.82$) and validity in both clinical and general populations (Bjelland et al., 2002). The original version of the HADS includes 4 response categories. This was changed to 5 in the current study to keep the number of response options the same across scales and constructs.

MTF and ABCD Items. The MTF dataset has a 4-item scale of depressive affect with items that appear to capture aspects of anhedonia (e.g., "It feels good to be alive") and dysthymia (e.g., "Life often seems meaningless"), the core components of depression. ABCD has one item related to depression, specifically, dysthymia; "I am unhappy, sad, or depressed".

Additional Measures

Additional measures related to NA were included to address the final aim by establishing criterion related validity. Neither the MTF nor ABCD datasets have items capturing anhedonia and emotional regulation. Alternatively, the items measuring aggression were taken exclusively from the MTF and ABCD datasets. Finally, the measures of impulsivity, behavioral inhibition/activation, and positive affect are established scales that are included in the ABCD (but not MTF) dataset.

Snaith-Hamilton Pleasure Scale (SHAPS). The Snaith-Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995) measures the extent to which an individual can experience pleasure

and the ability to anticipate pleasure. The scale consists of 9 items that capture the facets of social anhedonia and physical anhedonia. The SHAPS has been shown to be stable across time and demonstrates high internal consistency (α = .89) in both clinical and nonclinical populations (Langvik & Borgen Austad, 2019).

Difficulties in Emotion Regulation Scale (DERS). The Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) is a widely used 36-item measure of emotion regulation that consists of 6 subscales, of which two, awareness (α = .85) and strategies (α = .84), were included in the survey. The former specifically involves one's ability to identify and understand their emotions, while the latter refers to access to effective strategies for managing one's emotions. The two subscales were chosen based on research that shows them to be especially relevant when examining psychopathology (Fowler et al., 2014; Gross, 2015 ; Perez et al., 2012).

Short UPPS-P (SUPPS-P). The short version of the UPPS-P Impulsive Behavior Scale (Cyders et al., 2014) was used to measure impulsivity. On the shortened version, each subscale (Negative urgency, Lack of Perseverance, Lack of premeditation, Sensation seeking, and Positive Urgency) has 4 items, for a total of 20 items. The SUPPS-P has adequate reliability, intercorrelations comparable to that of the UPPS-P, and are similarly related to a number of outcomes predicted using the UPPS-P (Cyders et al., 2014).Only the negative and positive urgency subscales were used for the current analyses, as these subscales measure impulsivity in response to emotional states, specifically.

Behavioral Inhibition System/Behavioral Activation System Scales (BIS/BAS). The Behavioral Inhibition System/Behavioral Activation System Scales (BIS/BAS; Carver & White, 1994) are used to measure trait sensitivity to behavioral inhibition and activation systems. The

current survey included three subscales from the shortened version of the BIS/BAS. This includes the subscales of BAS-Drive (4 items), BAS-Fun seeking (4 items) and BIS (punishment sensitivity; 7 items).

Aggression. Aggression items were taken from the MTF and ABCD datasets. MTF includes a 3-item scale of interpersonal aggression ($\alpha = .72$) which captures the frequency of engaging in aggressive behavior over the past 12 months. The ABCD dataset similarly has 3 items related to aggressive behavior. Due to content overlap, 4 items total, two from each dataset, were included on the survey.

Positive Affect. Positive affect was measured using 7 items from the PANAS scale (Watson & Clark, 1994) described above (e.g., happy, excited).

Demographics

Demographic questions are included at the end of the survey. They include highest level of education completed, current employment, race/ethnicity, marital status, income, gender, and age. For the analyses, items were dichotomized and dummy coded as necessary.

2.1.4 Analysis Plan

Four sets of analyses were used to meet the study's four aims and all analyses were conducted in MPlus v 7.4 (Muthén & Muthén, 1998-2015). The first aim was to assess the validity of NA scales and items on the ABCD and MTF datasets. After first establishing appropriate levels of unidimensionality across constructs using confirmatory factor analysis (CFA), item response theory (IRT) was used for a more in-depth examination of item validity using the Graded Response Model (GRM) which was specifically adapted to deal with ordinal responses (Samejima, 1969). IRT is used to convert patterns of ordinal responses across items into a standardized continuous variable, theta (θ). Thus, for each individual model, θ represents

the "level" of the specific construct being examined, with zero representing the mean, and positive numbers indicating higher levels of the trait; negative numbers indicating lower levels. Each item has 4 difficulty parameters (b_{ic}) representing the value of theta at which a response option (1, strongly disagree to 5, agree) becomes more likely to be chosen in comparison to the response options below it. Each item also has 1 discrimination parameter (a_i), which represents how well the item differentiates between participants as a function of the latent trait (Thorpe & Favia, 2012; Wu et al., 2016).

The second aim was to test for differential item functioning (DIF) across demographic groups to identify measurement bias across subgroups. When DIF is present, it means that the item is functioning differently across levels of an extraneous variable (Wu et al., 2016). A series of MIMIC models were used to identify DIF across demographic groups (race/ethnicity, gender, education, and income). The models were first run with the covariates regressed on the latent trait. Modification indices from this analysis were used to identify any items that were also significantly related to demographic variables. The model was run again with the modifications and DIF was considered to be present if 1) model fit improved and 2) a demographic group was significantly associated with a specific item.

The third aim was to examine the structural relationship between factors to find evidence in support of either the convergent or divergent conceptualizations of NA. This was done using exploratory structural equation modeling (ESEM). ESEM is an analysis method that combines exploratory factor analysis (EFA) and CFA. Like CFA, the items can be assigned to specific factors, but, as with EFA, cross loadings are allowed (Asparouhov & Muthén, 2009). This is a more flexible and realistic way to approach psychological constructs, as rarely are items truly unidimensional, and studies show that allowing even very small cross loadings across factors

results in better model fit (Marsh et al., 2011). This type of analysis is especially appropriate when examining constructs that are theoretically related to one another (Morin et al., 2020), as is the case with NA. Furthermore, when cross-loadings exist, even as small as .10, but are incorrectly constrained to be zero, resultant model parameters are inflated (Asparouhov & Muthén, 2009; Asparouhov et al., 2015; Sass & Schmitt, 2010). Likewise, if an unmodeled general NA factor exists, as is suggested by the convergent hypothesis, parameter estimates in the first order model would also be inflated.

CFA uses the concept of a simple structure, wherein simpler models are preferred, and the simplest structure is that in which items load only on to one factor (Morin et al., 2020). As such, some may find the use of ESEM models, which allow cross loadings, as a violation of the rules of factor analysis. ESEM proponents argue, however, that theoretically, psychological constructs are rarely, if ever, so clear cut and well defined. As such, the use of an *approximate* simple structure, wherein cross loadings are allowed but must be small, is a more accurate representation of many constructs of interest. In other words, it theoretically makes sense to allow cross loadings and doing so not only improves model fit, but is also a more accurate representation of when there is a substantial amount of shared symptoms or characteristics across unique constructs (e.g., depression and anxiety; Morin et al., 2020).

Thus, to test this third aim, and following the analytic framework outlined by (Morin et al., 2016), a series of CFA models were compared (first order, bi-factor, and hierarchical models). These were then compared to first-order and bi-factor ESEM models (hierarchical ESEM models are not yet feasible; Morin et al., 2020). A better fitting first order model would support the divergent hypothesis, while better fitting bi-factor and hierarchical models would support the convergent hypothesis. Significant changes in model fit were determined using the

criteria outlined below. In the current analyses the presence of significant cross loadings was viewed as inevitable and were only of concern when 1) an item loaded equally, or more highly, onto a factor other than the one it was originally assigned to and, 2) when the absolute value of a cross loading was larger than .30 and was not easily explainable (Morin et al., 2020).

The fourth and final aim was to perform additional tests of convergent and divergent validity on the scales. This was done using ESEM-within-CFA (EWC; Morin et al., 2013). For this model, the item parameters were constrained to be equal to those from the best fitting ESEM model. Additionally, factors for the related constructs of emotional regulation (awareness and strategies subscales), urgency (positive and negative), aggression, positive affect, and three of the BIS/BAS subscales (BAS fun seeking, BAS drive, and BIS) were included to aid in establishing factor validity and further explore convergence and divergence of the NA subfactors. Syntax for the ESEM models was generated using an MPlus ESEM code generator (de Beer & van Zyl, 2019) available online at https://www.surveyhost.co.za/esem/.

Assessing Model Fit

Across all analyses, model fit was determined by looking at a combination of incremental and approximate fit indices: Comparative Fit Index (CFI; Bentler, 1990), Tucker-Lewis Index (TLI; Tucker & Lewis, 1973), Akaike Information Criterion (AIC; Akaike, 1987), and Sample-Size Adjusted Bayesian Information Criterion (SABIC; Schwarz, 1978). Standard cut off values for determining adequate fit were used. A model was considered to have good fit when it displayed a root mean square error of approximation (RMSEA; Steiger, 1980) and standardized root mean squared residual (SRMR; Bentler, 1995) below .06 and CFI and TLI values above .95 (Hu & Bentler, 1995). Additionally, factor loadings above .40 were considered acceptable for

inclusion in subsequent models. Finally, all models were allowed to include one modification, per the modification indices, if necessary.

Comparative model fit was assessed by examining changes in the indices described above. For AIC and SABIC, lower values are indicative of a better fitting model (Hu & Bentler, 1995). Reductions in RMSEA and SRMR values of .015 or more and changes in CFI and TLI >.01 were also considered necessary to determine that a model fit significantly better.

Interpreting IRT Parameter Results

IRT models provide a measure referred to as "test information" which shows how much information the test is able to obtain across levels of θ (Thorpe et al., 2007). Test information is easily converted into traditional measures of reliability by dividing the information value at a specific theta level by itself plus 1 (information/(information +1); Thorpe & Favia, 2012). In addition to test information functions (TIF), partial test information functions (pTIF) were obtained, which represent the amount of information provided by a subset of items. This was done so that the overall performance of items from different sources could be compared. Finally, item information curves (IIC) demonstrate information provided at the item level. Values of 1 or higher for information are considered good, while anything below 1 signals the item for removal (Thorpe & Favia, 2012).

Similar to information, discrimination parameter values above 1 are considered good, while anything lower is concerning but does not necessarily require elimination of the item θ (Baker, 2001). The *b*, parameters, however, simply identify a location on the theta scale. For the current models, *b* parameters for lower response options (1, strongly disagree and 2, disagree) are expected to fall below the mean ($\theta = 0.0$), 3 neither agree nor disagree around $\theta = 0.0$, and 4

and 5 (agree, strongly agree) above $\theta = 0.0$. The distance between *b* parameters aids in identifying whether response categories are necessary to include.

2.2 Results

2.2.1 Aim 1: IRT Analyses

IRT analyses were conducted to assess item validity, the first aim of the study. The fit statistics for each preliminary CFA model are shown in Table 4. All CFA models included methods factors (i.e., correlated-traits correlated methods models) to control for item source (Morin et al., 2020). Figure 1 shows the total information function (TIF) for each construct and Figure 2 shows the partial information function for each scale (pTIF). Table 5 contains all item parameter estimates, organized by construct and source. The following subsections break down the IRT results in detail, by NA dimension.

Anger

Information Functions. A methods factor for the PANAS items was included in the final CFA model as it resulted in better fit (for all constructs, CFA model results for the final model are presented in Table 3). An examination of the TIF (Figure 1a) shows that the items capture information best +/-0.5 SD from the mean (converted reliability estimate: $r = .88$). Adequate reliability (≥.70) extends from about -2.5 SD below and +3.3 SD above the mean ($\theta = 0$).

Fig 2a shows the partial information functions for the PANAS (3 items), ABCD (2 items) and MTF (1 item) items. As in CTT, scales with more items will always have higher reliability; in IRT this translates to more information about the construct of interest (Thorpe & Favia, 2012). Despite having one less item, the ABCD items capture more information than the PANAS items,

but the PANAS items cover a larger range of θ. Specifically, the reliability of PANAS items remain at $r \geq .60$ from -1.4 SD below to +3.0 SD above the mean, with a peak reliability of $r = .67$. The ABCD items have a calculated reliability of $r \geq .70$ from -1.2 SD to +1.8 SD, peaking at $r = .77$ across theta values of -0.6 to +0.5. Finally, MTF has only one item related to anger and it performed adequately well from -0.6 SD below to +1.2 SD above the mean with a peak information value of 1.26.

Item Parameters & ICCs. Individual item parameters are presented in Table 5, and the ICCs are presented in Figure 3. Items ang4 ang5 and ang6 have the highest *a* parameters, while ang1-ang3 have *a* values below the cut off of 1. The PANAS items (ang1-ang3) have a larger range of values, meaning they capture information across a wider range of θ, as was seen in the partial information functions (Figure 2). Ultimately it was decided to remove items ang2 and ang3 from subsequent analyses; ang1 had an *a* parameter very close to 1 ($a = 0.97$) and it was kept 1) to avoid further reducing the number of items on the scale and 2) because it provides information at higher levels of θ than any of the other items.

Anxiety

Initial CFA analyses revealed the 5 PANAS items did not load highly on the anxiety factor, even when a methods factor was included. Thus, they were removed from the analyses. Final model fit statistics are presented in Table 3.

Information Functions. An examination of the TIF (Figure 1b) shows that the anxiety items provide a large amount of information across a wide range of the theta. Information peaks across $\theta = -1.6$ to $\theta = 1.0$ (converted reliability estimate, $r = .96$) and remains adequate ($r \geq .70$) from $\theta = -3.6$ to $\theta = 3.4$.

As seen in Figure 2b, the STADI items provide the highest amount of information and cover the largest range of θ, peaking at r = .93 with $r \geq .70$ across θ = -2.8 to θ = 2.4. The 3 ABCD items perform second best with peak reliability of r = .83 across theta values of -1.6 to 0.20 and with $r \geq .70$ from θ = -2.0 to θ = 1.6. The 2 MTF items have a peak reliability of r =.70 from θ = -1.0 to θ = 0.0. This suggests that the MTF items are best at measuring anxiety levels around the mean and -1.0 SD below the mean. The MTF items provide acceptable reliability across theta values of -1.8 to 1.4 ($r \geq .65$). This is similar to the range of theta covered by ABCD items, but less than STADI.

Item Parameters & ICCs. Item characteristic curves are shown in Figure 4. The majority of b_{ic} parameters were significant, however, a number of items had insignificant b_{i3} parameters indicating that a 4-response option would be more appropriate. The best discriminating items were anx5, anx10, and anx14 with a = 1.35, a = 1.30, and a = 1.28, respectively. Items anx13 and anx15 (both from the STADI) had a parameters less than 1.00 and were removed from subsequent analyses.

Boredom

Information Functions. The boredom TIF (Figure 1c) shows that the 20 items adequately capture boredom θ = -3.6 to θ = 3.4, with a peak of r = 0.96 between θ = -.80 and θ =.40. As seen in Figure 2c, the ten MSBS-D items capture the construct of boredom best, with a max reliability of r =0.92 between θ = -0.6 and θ = 0.0 , and adequate reliability for levels of theta between -3.0 and 2.8. The 8 items of the BPS have a peak reliability of .88 across θ = -1.2 and θ = 1.2 and acceptable reliability extending between θ = -2.6 and θ = 2.6. Finally, the two items from MTF have adequate reliability across levels of theta between -1.2 and 0.5. Similar to the MTF anxiety items, these boredom items appear to best capture boredom levels around the

mean and -1SD; information obtained from the items drops below $r \geq .60$ around $\theta = -2.0$ and $\theta = 2.0$. Despite lower reliability relative to the longer scales, the IICs in Figure 2c show that the two MTF items (shown in green) are amongst the top performing items out of all of them. MSBS items b14 and b17 provide the least amount of information regarding the construct of boredom.

Item Parameters & ICCs. Boredom item parameters are shown in Table 5 and the ICCs are presented in Figure 5. All discrimination parameters indicate good fit and the b_{ic} parameters are significant across response categories except for *b3*, which was insignificant in 7 items. The majority of these are MSBS items thus indicating that the MSBS might benefit from the use of a four point Likert scale.

Depression

The initial CFA analyses of the depression items had poor fit and suggested a two-factor solution was more appropriate. The two factors that emerged were labeled "depression" and "anhedonia". Two of the MTF items fit better when included on the anhedonia factor versus the depression factor. This was not expected, but after examining the wording of the items ("I enjoy life as much as anyone" and "It feels good to be alive") they were consistent with conceptualizations of anhedonia as low levels of positive affect and lack of enjoyment or pleasure in life (De Fruyt et al., 2020) . Additionally, five of the seven HADS items loaded better on the anhedonia factor than the depression factor. An examination of the item wording (e.g., "I look forward with enjoyment to things") indicated that these items also had good face validity and were thus included on the anhedonia factor. The one caveat here is that all items on the anhedonia factor were positively worded (and thus, reverse scored) while those on the depression factor were all negatively worded. Being completely confounded by item wording, it cannot be

concluded, with certainty, that the items loading onto two separate factors is not due to differences in wording.

The next depression CFA, after removing the anhedonia items, also had a poor fit (*RMSEA* = 0.095 [90% CI: .09, .10]; *CFI* = 0.84; *TLI* = 0.81; *SRMR* = 0.065) but all of the factor loadings were above .40. MTF and PANAS method factors were included to remove any variance present due to scale differences; this resulted in much improved fit (*RMSEA* = 0.048 [95% CI: .039, .054]; *CFI* = 0.97; *TLI* = 0.95; *SRMR* = 0.035). One item from the PANAS scale (tired), no longer loaded above .40 on the depression factor and it was remove. Fit statistics for the final, 12 item CFA are presented in Table 3.

Information Functions. An examination of the TIF (see Figure 1d) shows that the items capture information best +/- 1.25 SD from the mean (converted reliability estimate: r =.91). Adequate reliability ($r \geq .70$) extends from θ = -3.0 to θ = 3.0. Figure 2d shows the partial information functions for the MTF (5 items), ABCD (1 item), PANAS (4 items) and HADS (2 items) scales. The MTF scale provide the most information with a maximum reliability of α = 0.88 (θ = -0.6 to θ = 0.2) with adequate reliability across levels of θ ranging from -2.0 to +2.2. The PANAS items capture a slightly wider range of θ, and have adequate reliability from θ = -2.0 to θ = 2.5. ABCD's one item does better on its own (maximum reliability r = 0.61 from θ = -0.8 to θ = 0.4) than the two HADS items combined.

Item Parameters & ICCs. Individual item parameters are presented in Table 5, and the ICCs are presented in Figure 6. The most discriminating items were d4, d5 and d6. Items d7 through d12 had *a* parameters less than 1 and were removed from subsequent analyses. Needing to remove this number of items was surprising and a series of sensitivity analyses were conducted to determine if the inclusion of MTF's self-derogation items (not originally designed

to measure depression), or the inclusion of a methods factor may have impacted the results; all versions ultimately led to the same conclusion. It was decided to keep item d8 ("sad") in the scale due to its relatively high *a* parameter ($a = 0.91$) and because it provides information at higher levels of θ than any of the other items. This resulted in a final 7-item depression scale with items from MTF (5 items), ABCD (1 item) and PANAS (1 item).

Anhedonia

As the SHAPS scale, another measure of anhedonia (all items also positively worded), was also included in the survey, a new CFA was run that included the six positively worded depression items and the SHAPS items on one factor; this model did not fit the data well (*RMSEA* = 0.095 [90% CI: .09, .10]; *CFI* = 0.83; *TLI* = 0.81; *SRMR* = 0.08). The model was then run again with methods factors for SHAPS and HADS and the model fit partially improved (*RMSEA* = 0.07 [90% CI: .06, .10]; *CFI* = 0.94; *TLI* = 0.92; *SRMR* = 0.09). The SHAPS items all loaded relatively poorly, however, indicating they should be removed from the model. An alternative 2 factor model was run with SHAPS included as a separate factor; model fit improved across all statistics (*RMSEA* = 0.058 [90% CI: .05, .06]; *CFI* = 0.94; *TLI* = 0.93; *SRMR* = 0.05) and the SHAPS and anhedonia factors were highly correlated ($r = .70$). Given that the SHAPS items did not load well and the two-factor model fit best, unidimensionality was not established. Thus, the construct of anhedonia, as measured by SHAPS was considered highly related, but ultimately different, from the HADS and MTF anhedonia items. The SHAPS items were not included in any subsequent analyses, resulting in a final anhedonia scale consisting of 7 items from the MTF (2 items) and HADS (5 items) scales.

Information Functions. Figure 1e shows that the anhedonia items capture information best from $\theta = 0.6$ to $\theta = 3.0$ (converted reliability, $r = .90$). The scale has adequate reliability (*r*

> 0.70) from θ = -2.2 to θ = 3.2. The partial information functions (Figure 2e) show that the HADS scale performs best, measuring anhedonia with an adequate level of reliability across θ = -1.8 through θ = 3.2. The scale has a peak reliability of r = 0.83 from θ = 0.0 to θ = 1.8. The MTF items performed well, with a peak reliability of r = 0.79 from θ = 0.1 to θ = 1.8.

Item Parameters & ICCs. Item parameters are presented in Table 5 and shown in Figure 7. Both of the MTF items performed well with high discrimination parameters. HADS items "I feel cheerful" and "I look forward with enjoyment to things" had low *a* parameters and were removed from subsequent analyses.

Summary of IRT Findings for Aim 1

In sum, the MTF and ABCD items performed very well alongside items from more established scales and the majority of items that needed to be removed did not come from MTF or ABCD. Due to having more items, established scales provided greater levels of information (i.e. reliability) than MTF and ABCD scales. Likewise, longer scales covered larger ranges of theta. Still, the ABCD and MTF items captured adequate and appropriate levels of theta across all constructs.

Unexpectedly, the depression construct had to be split into two: depression and anhedonia. The items on each construct were confounded by item wording with the depression construct having all negatively worded items and the anhedonia construct all positively worded items. While there was a strong association between the SHAPS and the HADS-MTF anhedonia factor (r = .70), ultimately it was determined that they were capturing different aspects or definitions of anhedonia and the SHAPS items were not used further.

The depression construct did not perform particularly well and the HADS and PANAS items were especially weak. The depression items from ABCD and MTF, however,

demonstrated that they were capturing the same construct. Together, these findings succeed in establishing the convergent validity of negative affect items used in the MTF and ABCD datasets. Though, the construct validity of the depression and anhedonia items remains undetermined.

2.2.2 Aim 2: MIMIC Models

The second aim of the study was to examine the scales for differential item functioning (DIF) by demographic groups. The best items from the initial IRT analyses were analyzed by construct using a series of MIMIC models. Only one item, from the STADI, displayed signs of DIF: "I am concerned about things that may happen in my future". For this item, older participants were more likely to endorse this item, even after controlling for overall levels of anxiety ($b = 0.12$, $p < .001$). Thus, when using the STADI, one may wish to control for age on this item to ensure proper measurement, when making comparisons across age groups. Lack of DIF by gender was of most concern for studies 2 and 3 and the results here provide confidence in the measures used for subsequent analyses.

Latent Mean Differences

After establishing the absence of DIF[1], latent means from the MIMIC models were able to be compared (see Table 6) and there were several significant associations. As the aim was to examine DIF, no hypotheses regarding group differences were made in advance. Having less than a 2-year college degree (coded 0) was associated with higher levels of anxiety ($b = -0.13$), boredom ($b = -0.11$), and depression ($b = -0.13$), and lower levels of anhedonia ($b = 0.10$).

[1] Even though there was one anxiety item with DIF by age, bias at the test level was not found via subsequent CFA measurement invariance testing. In other words, the overall meaning of the latent trait score was not biased by age.

Additionally, non-white individuals (coded 0) reported higher levels of anhedonia (b = -0.19) as did males (coded 1; b = 0.11). Higher levels of anxiety were associated with being female (b = -0.14) and being white (b = 0.13). Finally, age was negatively associated with anger and anhedonia (b = -0.14 and b = -0.27 , respectively).

2.2.3 Aim 3: ESEM Analyses

The third aim of the study was to examine the convergent and divergent hypotheses of NA. The findings show that the hierarchical model does not fit the data well and is significantly worse than the first order model (Δ *CFI* = -0.04, Δ *TLI* = -0.04, Δ *RMSEA* = 0.01, Δ *SRMR* = .06)[2]. The bifactor models, however, did fit the data well, but did not significantly improve fit when compared to the first order models (see Table 7). Finally, the ESEM models significantly improve fit when compared to their CFA counterparts. Thus, the first order ESEM model was chosen as the final model.

Ultimately, two items were removed due to poor loadings and high cross loadings (d1 and d2). The parameter estimates from the final ESEM model are shown in Table 8. The ESEM model showed that the data follows an approximate simple structure, with all cross loadings below b = 0.23 (Sass & Schmitt, 2010). Correlations between the latent variables in the final model are shown in Table 9. Overall, the findings were more in line with the divergent hypothesis than the convergent hypothesis of NA.

2.2.4 Aim 4: CFA-within-ESEM

[2] As anhedonia loaded substantially weaker on the higher order NA factor compared to the other subfactors, and because, theoretically, anhedonia is not a subcomponent of NA, a sensitivity analysis was run wherein only 4 factors (anger, anxiety, boredom, and depression) were modeled hierarchically. Overall fit improved only very slightly and still did not come close to meeting the requirements for adequate model fit.

The final model run was a CFA-within-ESEM. This addressed the final aim, which was to further assess criterion related validity and the convergent and divergent hypotheses of NA using additional constructs. Items were constrained to their factor loadings from the final ESEM model (shown in Table 8) and additional factors were added; positive affect (PA), emotional regulation awareness subscale (ER-A), emotional regulation strategies subscale, aggression, positive urgency (PU), negative urgency (NU), two behavioral activation subscales from the BIS/BAS, drive (BAS-D) and fun-seeking (BAS-F) and the behavioral inhibition subscale (BIS). These factors were correlated with NA to compare associations across facets. Associations were only considered significant at $p < .01$.

Basic on the existing literature, it was predicted that 1) anger would be strongly, positively associated with aggression, BAS measures, and positive and negative urgency 2) depression and anxiety would be positively associated with BIS and negative urgency 3) anhedonia would be associated with depression, but not anxiety 4) boredom would be positively associated with BAS (fun seeking) and BIS and 5) all NA constructs would be negatively associated with emotional regulation and positive affect.

Several interesting patterns emerged, shown in Table 10, and the majority of the hypotheses were confirmed. In general, anxiety, boredom, and depression had similar patterns of association with a few divergent associations per construct; anxiety was not associated with aggression, boredom was not associated with positive affect, and depression was not associated with ER-A. As predicted, anger had a high, positive association with aggression ($r = 0.68$), high, positive associations with positive and negative urgency ($r = .67$ and $r = .67$, respectively) and was significantly associated with BAS-D ($r = .17$), but not BIS. Likewise, as predicted, boredom was positively associated with BIS ($r = 0.55$) and BAS-F ($r = 0.42$) and anxiety and depression

were positively associated with BIS (r = 0.70 and r = 0.30, respectively), positive urgency (r = 0.27 and r = 0.54, respectively) and negative urgency (r = 0.60 and r = 0.61, respectively). Additionally, all facets of NA were associated with emotional regulation. Though, hypotheses regarding positive affect were only partially supported with only anxiety and depression being significantly associated, and the effect sizes were small (r = -0.15 and r = -0.17, respectively).

Anhedonia stood out in many ways in that it was the only construct not significantly associated with positive and negative urgency or ER-S and it was the only construct to have a large, negative association with PA (r = -0.54). Additionally, it was the only construct with negative associations with the BIS (r = -0.33), BAS-D (r = -0.53), and BAS-F (r = -0.51). Finally, latent mean correlations (see Table 9) indicated a moderate positive association between anhedonia and depression (r = 0.29) and a small negative association between anhedonia and anxiety (r = -0.15); this follows the expected pattern of results between constructs. All in all, the pattern of associations were as expected thus providing additional evidence of construct validity via content and divergent validity. Together, the differing associations between NA facets and small to moderate correlations amongst factors provides further support for the divergent hypothesis of negative affect.

2.3 Discussion

The current study examined the structure and measurement of negative affect (NA) in a sample of late adolescents and young adults. First, the construct validity of scale and survey items was compared across four NA facets (anger, anxiety, boredom, and depression) using item response theory (IRT). From there, differential item functioning (DIF) was tested with a focus on gender bias. An exploratory structural equation modeling (ESEM) framework was then used to test the validity of the convergent and divergent theories of negative affect, as well as to establish

further evidence of construct validity. The IRT results showed that, overall, survey items within the MTF and ABCD datasets are measuring the constructs they were intended to measure, and, they do so adequately well. DIF analyses revealed no major concerns when comparing patterns of responses across demographic groups (age, gender, race/ethnicity, and education). The ESEM analyses showed that the bifactor and hierarchical models do not significantly improve fit when compared to first-order models. Furthermore, ESEM models significantly improve fit when compared to their CFA counterparts. Together this suggests that NA is best conceptualized as being comprised of distinct but related factors, as is put forth by the divergent hypothesis of NA. Differing patterns of association with psychopathology constructs in the final ESEM-within-CFA (EWC) model further suggest the utility of examining NA at the individual facet level.

Construct Validity

The first two aims of the current study were 1) to confirm the validity of NA items in the MTF and ABCD datasets (anxiety, boredom, depression, and anger) and 2) to identify any DIF present in the items. This was done using IRT. The MTF and ABCD items all loaded onto their intended constructs (except for the two MTF depression items that loaded best onto the anhedonia factor) and performed well when compared to items from longer, established scales. While they did not provide as much information as the longer scales, they covered similar levels of θ and the ICCs indicated that the items measured the underlying latent construct well. Thus, MTF and ABCD items are 1) validated against longer, well-established scales (anxiety, boredom) and, 2) measures of anxiety, depression, and anger, are capturing the same construct, across datasets. This allows for more confidence in the findings when using these datasets and allows for a direct comparison of findings across datasets. Finally, the DIF analyses revealed no bias in any of the MTF or ABCD items.

PANAS Items

A number of Positive and Negative Affect Schedule Extended (PANAS) items were included in the survey. The PANAS items performed particularly poorly and were removed from the final models. In the IRT analyses, the PANAS subscales provided lower amounts of information, but covered a wider range of theta. The ESEM analyses showed that they had several small to moderate cross loadings. Together this suggests that the PANAS items are better at measuring a general NA construct, as opposed to individual facets of NA. This is not entirely unexpected given that the scale was originally designed to measure NA more broadly, as opposed to more specific affective states (Watson et al., 1988). The findings here indicate that further subdivisions of PANAS items, beyond positive and negative affect, are not appropriate; they do not capture individual domains of NA such as depression, anxiety, anger, etc., and should not be used to measure these constructs individually. Alternatively, while the other scales response options ranged from 1 (strongly disagree) to 5 (strongly agree), the PANAS items had response options ranging from 1 (slightly) to 5 (extremely). In other words, the PANAS items may be measuring the *intensity* of individual emotions experienced by the participant, while the others capture something more akin to the *frequency* of specific affective experiences. Finally, despite the question asking for participants to report how much they experience each emotion in general, the design of the scale may make it best equipped to measure affective states (vs. traits) as it was originally designed.

Depression & Anhedonia Items

Several unexpected issues arose when examining the depression scales. The items did not all load together onto one construct and instead split into two: anhedonia and depression. MTF had two items that loaded onto the anhedonia subscale while ABCD had none. The HADS

anhedonia items also loaded onto the anhedonia construct, but the HADS depression items ultimately did not perform well and were removed from the final models. In the end, the depression factor consisted of only MTF and ABCD items. Thus, while MTF and ABCD are clearly measuring the same construct, it is unclear whether or not this can be labeled "depression". At the very least, it is not measuring the same construct as the HADS scale.

It is unclear why this is the case, though it may be due to each scale capturing different facets of depression. While MTF and ABCD appear to capture feelings of despair, hopelessness, lack of meaning, and sadness, the 2 HADS items appear to capture physical symptoms ("I feel as if I am slowed down"). It was also considered that the inclusion of "self-derogation" items from the MTF dataset on the depression factor may have shifted the meaning of the construct. However, sensitivity analyses were conducted that excluded the self-derogation items and the results were the same. Regardless, the original goal of establishing content validity was not achieved for the depression items and further investigation is needed.

A factor labeled "anhedonia" unexpectedly emerged when examining the depression items and included two items from MTF and five items from the HADS. Anhedonia has multiple definitions in the literature including lack of emotion (i.e. numbness), lack of motivation, or an inability to experience pleasure (Shankman et al., 2014). The factor correlated highly with the SHAPS anhedonia measure but the SHAPS items did not load well alongside the MTF-HADS anhedonia items when included in the same model.

Of particular concern, the anhedonia and depression scales were entirely confounded by wording; each anhedonia item (including the SHAPS items) was positively worded while each depression item was negatively worded. The inclusion of positively and negatively worded items on a scale is often recommended as a way to curb inattentiveness (Nardi, 2018). However,

several studies have shown that that mixing positively and negatively worded items on a scale reduces reliability and validity and can lead (Weems et al., 2003; Zeng et al., 2020). Furthermore, it is not uncommon that mixed valence wording results in separate factors (DiStefano & Motl, 2006; Quilty et al., 2006). Finally, research shows that the way people respond to positively and negatively worded items varies based on a number of traits (Weems et al., 2003). This non-relevant variance being captured by the items is especially problematic.

Despite this major limitation the anhedonia items were kept as a separate factor for subsequent analyses. ESEM models did not reveal any anhedonia items with concerning cross-loadings. Furthermore, in EWC analyses, the anhedonia factor showed patterns of association that greatly differed from depression and are consistent with what would be expected based on the anhedonia literature (discussed further below). As the MTF depression and anhedonia items were to be used in study 3, additional supplementary analyses were conducted (see Appendix A).

The findings here reveal an important oversight regarding the validity of depression measures in psychology research. Studies are needed to clarify the measurement of anhedonia, depression and any relevant subdimensions, as well as to identify which aspects of depression are being measured by commonly used scales in the field.

ESEM Analyses

The third aim of the study was to test the convergent and divergent hypotheses of NA. Proponents of the convergent hypothesis claim that individual NA facets such as anxiety or anger, are, in fact, the result of the same underlying trait of negative emotionality. As such, examining each type of NA individually is not a useful endeavor (Diener et al., 1995). Proponents of the divergent hypothesis argue the opposite; that negative affective states are unique with different causes and behavioral responses (Barclay et al., 2005; Roseman et al.,

1994). Bifactor and hierarchical models were compared to first order factor models in order to determine if an overall NA factor existed. These CFA models were then compared to ESEM models wherein cross-loadings were not constrained to be equal. This analytic approach not only makes intuitive sense when examining theoretically related constructs, but it prevents the inflation of parameter estimates due to unmodeled relevant variance (Morin et al., 2020). The findings showed 1) that the hierarchical model did not fit the data well, 2) ESEM models fit the data significantly better than the CFA models and 3) that the bifactor models did not significantly improve model fit over the first order factor models. Together these findings provide more support for the divergent hypothesis than for the convergent hypothesis[3].

Structural Associations

ESEM-within-CFA (EWC) was used to address the final aim of the study which was to provide evidence of discriminant and criterion related validity and further probe the data for evidence regarding the convergent and divergent hypotheses. This was done by looking at the patterns of association between NA factors and psychopathology related constructs: behavioral inhibition/activation, positive and negative urgency, aggression, positive affect, and emotional regulation. Several associations emerged that aided in validating the constructs and each of the hypotheses were supported. Since the emergence of an anhedonia factor was not expected, no a priori hypotheses were made and it is discussed separately below.

As predicted, all NA constructs were negatively associated with emotional regulation and positive affect and positively associated with positive and negative urgency. Access to emotional

[3] Despite ultimately selecting the first-order ESEM model, which supports the divergent hypothesis, it should be emphasized that the convergent hypothesis was not disproved by the findings presented here. Specifically, it was not that the bi-factor model (which supports the convergent hypothesis) did not fit well, it simply did not fit *better* than the first-order model. Thus, the convergent hypothesis is not entirely disproved and using a general negative affect trait may be preferable in certain instances.

regulation strategies (ER-S) was moderately to strongly negatively associated with anger, anxiety, boredom, and depression. Lack of awareness of one's emotions (ER-A) showed a small positive association with both anxiety and boredom. Both of these findings are consistent with the literature linking emotion regulation to increased levels of negative affect (Beauchaine & Cicchetti, 2019). Positive affect, on the other hand, was only significantly associated with anxiety and depression; though, the effect sizes were small. Similar findings have been reported in the literature with weak associations found between positive and negative affect; thus, emphasizing the need to look at positive and negative affect separately and not equate high NA with low positive affect (Lan et al., 2021; Watson et al., 1999).

Consistent moderate to strong positive associations were found between each negative affect dimension and positive and negative urgency. This supports previous studies that have consistently shown that impulsivity, negative urgency in particular, is associated with internalizing symptoms. Positive urgency was most strongly associated with anger which replicates similar findings in the externalizing psychopathology literature (Bresin, 2019). Anger also, as predicted, had the strongest association with aggression. Boredom had a small positive association with aggression and depression had a moderate positive association. Anxiety was the only NA facet to have no significant association with aggression. This is consistent with the notion that anxiety leads to withdrawal behavior, as opposed to approach behavior (Baas et al., 2020; Beauchaine, 2015). This is further supported by the strong positive association seen between anxiety and behavioral inhibition.

Boredom

Although boredom is not usually considered a component of NA, the current analyses included it due to rising empirical interest in the construct. Boredom had the strongest positive

association with fun-seeking (BAS-F), a construct similar to sensation seeking, and, like depression, had strong positive associations with positive and negative urgency, and strong negative associations with ER-S. They also both had positive associations with the BIS/BAS scales and aggression, though the effect sizes differed. The findings here also show that boredom is similar to anxiety in that they were the only two constructs positively associated with ER-A and that they had the strongest positive associations with BIS. Boredom was also somewhat unique in that, like anger, it was not significantly associated with PA. Given that the overall pattern of associations found for boredom was very similar to those found for anxiety and depression, along with the strong association between the 3 constructs, future NA research should consider including boredom as a relevant form of NA.

Anhedonia

Anhedonia showed the most divergent pattern of associations across the constructs. It was the only construct negatively associated with BIS, BAS-F, and behavioral activation system, drive subscale (BAS-D) which is consistent with the literature indicating anhedonia is the result of deficits in the reward system circuitry of the brain (Zisner & Beauchaine, 2016). It was also the construct most strongly, and negatively, associated with emotional awareness and not significantly associated with positive and negative urgency. This is consistent with conceptualizations of anhedonia as a lack of emotion, either positive or negative (DePierro et al., 2014; Shankman et al., 2014). Finally, as has been reported in the literature previously, anhedonia had a much stronger negative association with positive affect than did depression (Naragon & Watson, 2009).

Strengths and Limitations

The current study is limited in that only so many items and scales could be included on the survey. Instead of focusing on several scales measuring just one construct, one or two scales were used to assess construct validity. This, however, is also a strength, in that it allowed for an all-encompassing look at NA measures and their structural relationship to one another. Still, issues and questions surrounding the depression measure emerged that could not be addressed due to lack of additional depression scales to use for comparison. Likewise, the anger, anhedonia, and depression scales ended up with fewer items than was ideal. The results of the current study regarding these constructs should be interpreted with caution as further studies are needed. It is particularly important to find a way to look at anhedonia and depression without the issue of positively worded items confounding the results.

Other elements of the survey may have impacted the findings. The response category options were changed for some scales so that all items would have a total of 5 response categories. This decision was necessary to appropriately use the IRT Graded Response Model and did not appear to affect the findings. Still, this departure from the original presentation of items should be taken into consideration. The sample used was obtained with an attempt to be close to nationally representative in terms of demographics. Still, recruiting participants via Qualtrics may have impacted the data. This is not a major concern, however, as IRT analyses are not sample dependent; that is, levels of theta within a sample do not impact results (Hambleton et al., 1991). Although the sample size was relatively large, given the complexity of the models tested, the findings should be replicated in larger samples.

Finally, an important limitation of the current study is the lack of participants under the age of 18. As such, the developmental validity of the measures in younger samples, as are found

in MTF and ABCD, was unable to be examined. This limitation allows for only tentative claims to be made about validity outside of ages 18 to 30. Thus, while study 1 provided a needed initial examination of validity and was able to establish convergent validity across datasets, it is still unknown if the same results would be found using younger samples. This highlights the need for the field of developmental psychology to place a larger focus on psychometric studies that focus on differential functioning across age and development stage.

Despite these limitations, a major strength of the current study was the ability to utilize advanced modeling (ESEM and IRT) to better understand the structure and measurement of NA constructs. The main strength of this study was the use of advanced, in-depth psychometric analyses to evaluate the validity of survey measures. Attempts to address survey item validity in national datasets in such an in-depth manor is not something that is often done. Multiple established scales were used establish convergent validity and the survey items came from two well-established and widely used datasets. Thus, the implications of the findings have the potential to be far-reaching.

Implications and Future Directions

The findings from the current study showed that items used in the ABCD and MTF datasets performed relatively well to more established scales and convergent validity was able to be established across datasets for most items. It should be noted, the current study focuses specifically on convergent validity, the extent to which sets of items are measuring the same construct. Convergent validity is only one form of construct validity and the findings here cannot speak to other forms of construct validity such as content validity (Zumbo & Chan, 2014). As such, further studies on additional aspects of construct validity are needed to fully address the issue.

Large datasets are particularly useful for modeling the complex relationships like those in psychopathology but a common weakness is poor or limited measurement (Bound et al., 2001). The findings of the current study suggest that, despite having only one or two items per NA construct, the items are valid and function adequately to capture the constructs of interest. By eliminating concerns of major measurement and validity issues in these datasets, conclusions drawn from past and future MTF and ABCD research findings using NA constructs are strengthened. Furthermore, given the strong convergent validity, research findings across these datasets are able to be compared directly when NA constructs are involved. This is especially valuable for developmental psychopathology research as large datasets such as these are particularly useful for modeling complex relations such as NA and substance use in adolescence.

Conclusions

The validity of survey items from the MTF and ABCD national datasets was able to be established, providing greater confidence in past and future research findings. Structural relationships between the NA factors more strongly supported the divergent hypothesis of NA as opposed to the convergent hypothesis. The findings here also highlight the need for more psychometric studies examining the measurement of NA and mental health related symptomology. Constructs must be clarified before progress can be made with deciphering the association between internalizing disorders and their association with substance use.

Chapter 3 Transdiagnostic Indicators of Psychopathology: Neural Correlates and Comorbidity

The study of developmental psychopathology focuses on the emergence and progression of psychopathology throughout the life span (Beauchaine et al., 2018). Despite a long history of attempts to categorize, define, and label psychopathologies, rarely do they present as clear cut and purely defined as would be desired. As a result, research is moving towards a more dimensional conceptualization of psychopathology (Kotov et al., 2017). The current study aims to better understand the underlying dimensions of psychopathological conditions using the trait indicators of negative affect (NA) and impulsivity in a pre-adolescent sample from the Adolescent Brain and Cognitive Development dataset (ABCD; Jernigan et al., 2018). First, subdimensions of NA and impulsivity are used to predict comorbidity. Secondly, brain base set (BBS) modeling is used to identify neuro-correlates of trait impulsivity that are present in pre-adolescence. Together the findings set a baseline for future longitudinal studies using ABCD participants as they mature throughout adolescence. The following sub sections selectively review the relevant literatures on adolescent development, psychopathology, transdiagnostic indicators, and gender differences.

Adolescent Development

Adolescence is a time of tremendous growth and change. It is a developmental period marked by exploration, identify formation, and biological changes, including brain maturation (Casey et al., 2008). Adolescents have been shown to be more emotionally volatile than adults and children and display increased levels of negative affect, especially in response to stressors

(Larson & Asmussen, 2017; Spear, 2000b). They are also more likely to react impulsively while experiencing intense affective states (Steinberg, 2005). Neurological studies on adolescents provide further evidence of elevated levels of negative affect and impulsivity during this time period (Romer, 2010; Vijayakumar et al., 2019).

Dual systems models of adolescent brain development focus on a developmental imbalance between two distinct neurological systems; the socioemotional system, responsible for emotion and reward processing (Mills et al., 2014; Steinberg, 2010) and the cognitive control system which manages emotional regulation, decision making, and impulse control (Hare et al., 2008; Steinberg, 2005). The former, compromised of the amygdala and ventral striatum, develops early on in adolescence coinciding with the onset of puberty (Galvan, 2010). The latter, made up of the prefrontal cortex (PFC) develops more gradually, reaching maturity in early adulthood around the age of twenty-five, and possibly even later (Hare et al., 2008).

Myelination and synaptic pruning, the processes that allow for swift communication between brain regions is also not fully developed in adolescence. Thus, the systems of the brain are less integrated (Spear, 2000a; Steinberg, 2010). The structurally immature PFC and incomplete brain integration result in a less consistent ability to regulate affective states, consider consequences of behavior, inhibit impulses and, make plans. This is especially true when adolescents experience states of elevated emotionality (Steinberg, 2005). These dual-systems models are often used to explain a number of behaviors associated with adolescence including heightened emotionality, self-harm, risk-taking, sensation seeking, substance use, and the emergence of psychopathology (Defoe et al., 2015 248; Harden & Tucker-Drob, 2011; Luciana, 2013; Vijayakumar et al., 2019).

Psychopathology

Psychopathology outcomes are the result of complex, and still not fully understood, interactions between genetic predispositions and one's environment (Beauchaine & Hinshaw, 2020; Beauchaine & Zisner, 2017). Adolescence represents a period of heightened vulnerability to these risk factors with several disorders emerging or peaking in severity during adolescence (Skodol & Bender, 2008). Early prevention, identification, and treatment are linked to higher levels of well-being and less negative consequences across the lifespan (Farmer et al., 2013; Lynam et al., 2009; Maslowsky et al., 2013). It is for these reasons that adolescence, in particular, is a period of interest in psychopathological research.

Psychopathological disorders are often grouped into two domains: internalizing and externalizing. The former are characterized by negative internal experiences of emotion (i.e., depression and anxiety) while the latter are identified by outward displays that are disruptive, delinquent, or antisocial in nature (e.g., ` ADHD, conduct disorder; Beauchaine et al., 2017). Despite ample evidence supporting this two factor structure[4] (Gluschkoff et al., 2019; Lynch et al., 2021) rarely, in practice, do disorders present in such a clear cut fashion (Beauchaine & Hinshaw, 2020). Along these lines, recent evidence suggests that there also exists a higher order psychopathology factor, "p", that accounts for shared variance across internalizing and externalizing dimensions (Caspi & Moffitt, 2018).

Comorbidity

Comorbidity refers to the presence of more than one disorder (Angold et al., 1999) and is linked to worse treatment outcomes (Walczak et al., 2018). For example, major depressive

[4] Studies also report a third factor "disordered thinking", that is suggested to be responsible for disorders such as schizophrenia (e.g., Beauchaine & Zisner, 2017). However, disorders of psychosis are not the focus of the current studies and thus, are beyond the scope of the current review.

disorder (MDD) and anxiety disorders are often comorbid; meaning they often occur together within an individual (Hankin et al., 2016). As both depression and anxiety are considered internalizing traits, this is an example of homotypic comorbidity. Heterotypic comorbidity, on the other hand, occurs when two or more disorders are present that fall into the internalizing and externalizing domain (Schettini et al., 2021; Zisner & Beauchaine, 2016). Although internalizing and externalizing dimensions do not share any criteria, those with heterotypic comorbidity often display higher levels of dysfunction than those with homotypic comorbidities, those with a single diagnoses, or none at all (Mahendran et al., 2021; McDonough-Caplan et al., 2018).

Studies have shown that comorbidities are associated with varied levels of functioning across neural systems in the brain (Beauchaine & McNulty, 2013; Zisner & Beauchaine, 2016). Internalizing disorders are associated with normal reward-system functioning and an overactive septohippocampal system while individuals with hypofunctioning reward and septohippocampal systems are more at risk for externalizing disorders. Although studies examining heterotypic comorbidity are few, those with heterotypic comorbidities have been shown to have septohippocampal functioning more similar to those with internalizing disorders, and deficient reward processing in the mesolimbic system, as is found in those with externalizing psychopathology alone (Sauder et al., 2012 169; Zisner & Beauchaine, 2016). Even fewer studies have examined heterotypic comorbidity at the trait and behavioral levels. In one example, Maslowsky and Schulenberg (2013) found that higher levels of adolescent substance use were associated with having high levels of both depressive affect (internalizing) and conduct problems (externalizing). At the trait level, continuous latent traits, called transdiagnostic indicators, have begun to receive greater attention in the literature.

Transdiagnostic Indicators

Inspired, in part, by the existence of heterotypic comorbidity, recent conceptualizations of psychopathology are moving towards a more dimensional approach (Beauchaine et al., 2018; Forbes et al., 2016). Transdiagnostic indicators refer to underlying traits that are found across internalizing and externalizing disorders (Hankin et al., 2016; Kotov et al., 2017; Zisner & Beauchaine, 2016). While various terms are used throughout the literature to describe the transdiagnostic indicators of psychopathology, the most two most consistent indictors ultimately boil down to the presence of negative affect (also termed neuroticism or negative emotionality; Beauchaine & Tackett, 2020) and deficits in self-regulation (including impulsivity, emotional dysregulation, and behavioral disinhibition; Beauchaine & Cicchetti, 2019; Zisner & Beauchaine, 2016). While NA is often considered a core feature of internalizing disorders, high levels are also found in those diagnosed with conduct disorder (CD) and substance use disorder (SUD; Dugre et al., 2020; Ezpeleta et al., 2020). Likewise, high levels of impulsivity, a trait often linked to risky behaviors and externalizing symptoms, is found in those with depression and has been shown to predict suicidal behavior (Conner et al., 2004; Dugre et al., 2020).

Despite research consistently linking these traits to multiple disorders across the internalizing-externalizing spectrum, DSM diagnoses fail to capture these vulnerabilities, and many child and adolescent psychopathologists continue to rely on DSM diagnoses in their research (Beauchaine & Hinshaw, 2020). This inhibits the field's ability to better understand the true etiology of psychopathology and comorbidity thus limiting efforts aimed at treatment and prevention. The current study takes a transdiagnostic approach to link DSM diagnoses to trait levels of negative affect and impulsivity, with a focus on the prediction of heterotypic comorbidity. Relatedly, A number of neuroimaging studies continue to rely on identifying neural

correlates of DSM disorders (Beauchaine & Hinshaw, 2020). Less work has been done linking neurological systems to transdiagnostic indicators, specifically (see Zisner & Beauchaine, 2016 for exceptions). As such, the second aim of the current study is to examine neural correlates of one such transdiagnostic indicator, impulsivity, in resting state fMRI data in a preadolescent sample.

Negative Affect

Trait negative affect (NA) refers to the tendency experience unpleasant (or "negative") emotional states (Hankin et al., 2016). It is linked to weak or maladaptive emotional regulation skills and is commonly considered a core feature of internalizing disorders (Beauchaine, 2015). NA can include either high or low arousal states leading to multiple sub-facets, most commonly grouped into 3 categories: fear/anxiety, sadness/depression, and anger/irritability (Stanton & Watson, 2014).

Psychopathology is characterized by dysregulation of NA, wherein an individual experiences an emotion either too intensely or for an excessively long duration (Beauchaine & Cicchetti, 2019). Internalizing disorders involve dysregulated levels of avoidant or withdrawn related affect such as sadness and fear. Externalizing disorders involve dysregulated levels of approach related emotional states such as anger (Beauchaine & Zisner, 2017). Furthermore, affective states are linked to risk taking behaviors such as substance use in that they impair one's ability to use self-control behaviors (Muraven & Baumeister, 2000), undermine rational decision making (Bechara, 2005), decrease discriminative utilization of information (Forgas, 1992), and are associated with poor decision making outcomes (Stout et al., 2004).

Impulsivity

Impulsivity refers to the inability to self-regulate one's behavior in favor of long term

goals and is often expressed as a preference for smaller, immediate rewards versus larger, but delayed rewards (Stautz & Cooper, 2013; Zisner & Beauchaine, 2016). The most basic division of impulsive dimensions starts with differentiating between behavioral and cognitive/personality characteristics. Behavioral approaches focus on observable behaviors without examining individual traits (Whiteside & Lynam, 2001). On the other hand, personality approaches view impulsivity as a characteristic (or trait) that an individual possesses which, in turn, guides behavior (Cyders & Smith, 2008). While both conceptualizations of impulsivity have been linked to risk taking and substance abuse (Cyders & Smith, 2008), the latter is more useful for identifying at risk populations (Jentsch et al., 2014) and is the focus of the current study.

Sub-Dimensions of Impulsivity

Analyzing multiple scales related to impulsive traits Cyders and Smith (2007) identified three correlated, but distinct components: deficits in conscientiousness, emotion based rash actions, and sensation seeking. These dimensions of impulsivity have been linked to a number of behavioral and clinical outcomes during adolescence (Cyders & Smith, 2008; Lejuez et al., 2010). The current study focuses on two of these dimensions: deficits of conscientiousness (lack of premeditation and lack of perseverance), and emotion based rash actions (positive urgency and negative urgency) as measured and conceptualized by one of the leading impulsivity scales in psychology, the UPPS-P (Whiteside & Lynam, 2001).

Deficits of Conscientiousness: Lack of Premeditation and Perseverance. Lack of premeditation (Whiteside & Lynam, 2001) refers to a lack of reflection on potential consequences of one's behavior with a preference for smaller, immediate rewards as opposed to larger, delayed rewards. Individuals who score highly on this dimension (indicating a lack of premeditation) are more likely to engage in risky behavior and suffer more negative

consequences (Stautz & Cooper, 2013). Lack of perseverance (Whiteside & Lynam, 2001) refers to the inability to remain focused on tasks perceived especially when perceived as difficult or boring. Individuals with high scores on this subscale (indicating less perseverance) experience higher levels of boredom and struggle to complete tasks they find to be unpleasant, especially in the face of distracting stimuli (Berg et al., 2015).

Studies on these two dimensions of impulsivity have shown consistent links with a number of addictive behaviors and psychopathology (Berg et al., 2015; Coskunpinar et al., 2013). The strength of these associations, however, is usually overshadowed by the larger effect sizes found for emotion based rash action, and negative urgency in particular (Berg et al., 2015; Cosi et al., 2011; Romer Thomsen et al., 2018; Stautz & Cooper, 2013).

Emotion Based Rash Action: Positive and Negative Urgency. The personality traits of positive and negative urgency refer to individual differences in the propensity to engage in risky behaviors while experiencing intense emotions (Cyders & Smith, 2008). The former refers to a proclivity towards impulsive and risky behaviors in response to high levels of positive affect, the latter, a proclivity towards impulsive action and risky behaviors in response to negative affect. Both positive and negative urgency are associated with psychopathology and risk behaviors, such as substance use (Smith & Cyders, 2016 ; Verdejo-Garcia et al., 2007; Whiteside & Lynam, 2001; Whiteside & Lynam, 2009). Furthermore, these associations hold in both clinical and nonclinical samples, and in cross-sectional and longitudinal designs (Carver & Johnson, 2018; Gay et al., 2008). Throughout the literature, negative urgency is beginning to emerge as a key indicator of psychopathology severity and related outcomes (Smith et al., 2007). This further suggests that NA and impulsivity are key underlying transdiagnostic indicators that warrant more in depth attention.

Impulsivity and NA Neural Substrates

Impulsivity and affect stem from subcortical brain regions that mature early in life while the regulation of emotional states and impulses occur in the PFC which continues to develop into young adulthood (Beauchaine & McNulty, 2013; Hare et al., 2008). How extreme, dysregulated levels of NA manifest as specific psychopathologies depends on individual differences in the reactivity of, and communication between, multiple neurological systems (Beauchaine & McNulty, 2013; Gray, 1990). Specifically, behavior is determined by the interaction between the self-regulatory (i.e. PFC), approach, and avoidance systems of the brain. The approach system is linked to the ventral tegmental area (VTA) and striatum, while the avoidance/withdrawal system includes the amygdala and septo-hippocampal system (Beauchaine & Tackett, 2020).

It is suggested that increases in impulsivity during adolescence are a direct consequence of the mismatched developmental rates between the self-regulation system(Steinberg, 2010) and the approach/withdrawal system (Beauchaine & Tackett, 2020; Harden & Tucker-Drob, 2011). The relationship between these systems is reciprocal in nature and described as "bottom-up" processing and "top-down" processing. The former refers to amygdala activation communicating relevant events to the PFC. The latter process involves regulation of amygdala activation and other emotion related areas by the PFC. This top-down processing acts to aid in information processing and long-term goal orientation (Casey et al., 2008; Spinella, 2004).

High levels of impulsivity have been shown to correspond to reduced cortical thickness in numerous areas in the PFC including, the dorsolateral prefrontal cortex, the ventromedial prefrontal cortex, and the anterior cingulate cortex (ACC), among others (Chester et al., 2016; Smith & Cyders, 2016). Also among these regions of the PFC, the orbitofrontal cortex (OFC) has been specifically linked to the inability to regulate one's emotional responses in order to utilize

adaptive decision making and maintain long term goals (Levens et al., 2014). For example, individuals with OFC damage act more impulsively during states of affective arousal and display weaker planning skills (Bechara, 2004; Spinella, 2004). This increased impulsivity is suggested to be due to lack of top down processing in response to emotional stimuli.

With bottom-up processing, the amygdala projects "up" to areas of the PFC, including the OFC, when individuals are presented with emotional stimuli (Brown et al., 2015). The amygdala also projects signals to other "bottom" areas associated with reward processing leading to increases in emotional response to stimuli. It is most active in response to negative stimuli has been shown to be related to self-reported levels of negative urgency making it an area of continued interest and relevance to emotional impulsivity (Cyders et al., 2015; Smith & Cyders, 2016). The striatum and anterior insula (AIC) are additional relevant areas that have been linked to decision making, the anticipation of reward, and behaviors to obtain rewards. They function as part of the brain's reward circuitry and receive input from the amygdala (Smith et al., 2014).

Given the number of brain structures and networks implicated in trait impulsivity (Cho et al., 2013; Davis et al., 2013), the current study takes a whole brain approach to examine global patterns of resting state functional connectivity. Resting state functional connectivity data are well suited for this approach and involve measuring activity in the brain during periods of rest, wherein there is an absence of sensory and cognitive stimuli (Lv et al., 2018). Past research has led to the identification of several resting state networks in the brain (Power et al., 2011; Smitha et al., 2017),that have proven to be reliable indicators of psychopathology (Bolton et al., 2020 ; Karcher et al., 2020; Parkes et al., 2021).

Gender Differences

For decades, a number of studies have shown differences in the prevalence of specific

types of psychopathology and related traits and behaviors across gender. Despite this, gender moderation of psychopathological phenomenon are still rarely studied and poorly understood (Hartung & Lefler, 2019). Without addressing potential differences in manifestation and etiology across males and females, models of psychopathology are incomplete, at best. This, in turn, inhibits identification, prevention, and treatment efforts.

At the behavioral level, males and females report differing levels of NA, impulsivity, and rates of psychopathology. For example, females report higher levels of NA and are more likely to have an internalizing disorder than males (Rapee et al., 2019). Males, on the other hand, are more likely to act impulsively, engage in substance use, and be diagnosed with externalizing disorders (Cyders, 2013; Farmer et al., 2013; Stautz & Cooper, 2013). Given the dearth of focus on gender in psychopathology studies, it is possible that various methodological biases are to blame for differences found in the literature. However, with studies gradually beginning to incorporate gender and with improved sampling, other explanations have begun to emerge (Hartung & Lefler, 2019). More specifically, gender differences related to psychopathology have been suggested to stem from biological influences (e.g., hormones), environmental influences (e.g., gendered socialization), or a combination of the two. Studies support this notion, with pubertal status and timing consistently found to be associated with symptoms of psychopathology, especially for females (Graber, 2013; Rapee et al., 2019). Relatedly, externalizing symptomology has been shown to be negatively associated with femininity, while internalizing symptomology is negatively associated with masculinity (Hoffmann et al., 2004).

Current Study

Together, NA and impulsivity are two important transdiagnostic indicators that are not yet fully understood, but may be key to understanding the emergence and development of

psychopathology. Outside of the concept of negative urgency, the combination of NA and impulsivity has not been explored. Furthermore, heterotypic comorbidity is poorly understood and examinations of neural underpinnings related to transdiagnostic indicators are often under powered and inconclusive (Button et al., 2013). Using the large ABCD dataset, the current study first tests the hypothesis that differing combinations of NA and impulsivity predict comorbidity (externalizing only, internalizing only, or heterotypic) in an early/pre- adolescent sample. Specifically, impulsivity is expected to be a stronger predictor of having an externalizing disorder (EO), while negative affect is expected to be a stronger predictor of having an internalizing disorder (IO). Due to the lack of studies examining heterotypic comorbidity, no formal hypotheses were made regarding this subgroup (IxE), but they are expected to have more severe symptoms than either EO or IO groups. Given the discrepancies in the literature regarding gender, gender moderation is also examined. The second set of analyses uses brain base set modeling to examine the neural correlates of impulsivity facets in resting state fMRI data. Due to the wide range of structures linked to impulsivity, these analyses were exploratory in nature and no specific hypotheses were formed. Together these analyses aim to clarify the link between impulsivity and psychopathology, with and without the presence of NA, using neurological and self-report behavioral measures.

3.1 Method

3.1.1 Sample

The sample for the current analyses comes from The Adolescent Brain Cognitive Development Study (ABCD). ABCD is a longitudinal, multisite study that includes a comprehensive set of assessments covering physical health, cognition, social functioning, emotional development, environmental influences, behaviors, and academics. It further includes

neuroimaging, hormonal, and genetic data (Barch et al., 2018; Jernigan et al., 2018) A total of 11,878 participants were recruited for baseline data collection at the ages of 9 to 10 years old with data collected yearly until they reach the age of 19 to 20 years old. The sample closely aligns with the U.S. population across multiple demographic variables, including gender, race/ethnicity, parental education, marital status, and income (Garavan et al., 2018). Currently, two batches of data have been released that include the full baseline sample (Compton et al., 2019). The most recent release will be used for analyses, which is currently the baseline data (Annual Release 2.0, DOI: 10.15154/1503209). Due to missing data on some of the variables, the first set of analyses was limited to N = 3,500. Likewise, after applying exclusion criteria, the second set of analyses utilized N = 6,439 participants from the full sample. Descriptive statistics for each sample are shown in Table 11. Further descriptive information regarding those with and without missing data are shown in Appendix B.

3.1.2 Measures

Psychopathology

Kiddie Schedule for Affective Disorders and Schizophrenia for the DSM-5 (KSADS-5). Internalizing and externalizing disorders were measured using the Kiddie Schedule for Affective Disorders and Schizophrenia for the DSM-5 (KSADS-5), a well-established measure of psychopathology in children and adolescents (Kaufman et al., 1997). ABCD used a modified version of the KSADS-5, filled out by the parents of each participant (Barch et al., 2018). The measure categorically captures the presence of an array of internalizing (general anxiety, social anxiety, separation anxiety, agoraphobia, post-traumatic stress disorder, obsessive compulsive disorder, panic disorder, phobia and mood disorders) and externalizing (conduct disorder, operational defiant disorder, and attention deficit hyperactive disorder). For the current study, a

new categorical variable was created indicating (1) no mental health conditions (MHC), (2) internalizing disorder(s) only, (3) externalizing disorder(s) only, and (4) the presence of both an internalizing and externalizing disorder.

Impulsivity

Short Form of the UPPS-P (SUPPS-P). ABCD uses the short form of the UPPS-P (SUPPS-P), a well-established, and widely used measure of impulsivity (Whiteside & Lynam, 2001). The psychometric properties of the SUPPS-P have been shown to be comparable to the full-length version in terms of reliability, interrelations, and predictive validity (Cyders et al., 2014). The scale is comprised of five 4-item subscales: positive urgency, negative urgency, lack of planning, lack of perseverance, and sensation seeking. Response options ranged from 1(agree strongly) to 4 (disagree strongly). Items on the premeditation and perseverance subscales are reverse scored so that scores indicate *lack of* premeditation and *lack of* perseverance (i.e. higher scores indicate higher levels of impulsivity).

The sensation seeking scale was not used for the current analyses as it was not related to the aims of the study and preliminary studies on the ABCD data show poor internal consistency for the sensation seeking scale ($\alpha = .49$; Barch et al., 2018). Additionally, it has been argued that sensation seeking is a related, but unique, construct with evidence suggesting that it does not capture impulsivity as intended (Sharma et al., 2014). Thus, including the sensation seeking subscale did not make sense from either a statistical or theoretical standpoint.

Negative Affect

Items that were validated in study 1 were used to create scales measuring facets of negative affect: Depressive Affect (2-items), Anxiety (3 items), and Anger (2-items). These items come from ABCD as part of the Brief Problem Monitor (BPM) (Achenbach,

McConaughy, et al., 2017). Both the youth self-report (YSR) and teacher-report form (TRF) version (Achenbach, Ivanova, et al., 2017) included in the ABCD dataset were considered. In the current dataset, analyses revealed correlations between the YSR and TRF scales (see Table 12) ranged in strength from r = 0.17 (anxiety) to r = 0.25 (anger) which replicates previously reported cross-informant correlations of BPM scales (Achenbach, McConaughy, et al., 2017). As multicollinearity was not an issue, and due to the unique predictive ability of each version (Barch et al., 2018), both TRF and YSR versions of the scales created from BPM items were used in the analyses. Response options ranged from 0 (not true) to 2 (true).

Neuroimaging

Imaging acquisition for the ABCD study including scanning parameters is outlined in detail by Casey et al. (2018). The challenges associated with collecting data across multiple sites were addressed by using harmonized measures and procedures. One of three different 3T scanner platforms are used across sites: Siemens Prisma, General Electric (GE) 750, and Philips. Multi-channel, standard adult size coils were used. Scanning sessions followed a consistent order across sites as follows: localizer, 3D T1-weighted images, resting state fMRI, diffusion weighted images, 3D T2-weighted images, additional runs of resting state fMRI, and finally, a randomized presentation of 3 task based fMRI sessions For the fMRI scans, head motion was monitored using FIRMM (Dosenbach et al., 2017) which allows for real-time detection and adjustment.

3.1.3 Analysis Plan

Multinomial Logistic Regression

To address the first aim of this study, multinomial logistic regression models were used to compare the NA and impulsivity make up of individuals reporting homotypic and heterotypic comorbidity. Controlling for demographics, mean scale scores for each type of impulsivity and

negative affect were used to predict membership in 1 of 4 categories: no mental health condition (MHC), internalizing only, externalizing only, and the presence of both internalizing and externalizing disorders (i.e. heterotypic comorbidity). The data were analyzed in SPSS 22 and both TRF and YSR self-report measures were used as predictors. The same models were then repeated by gender and compared to examine evidence of gender moderation.

Brain Base Set Modeling

The aim of the second analysis was to identify neural correlates of impulsivity using a whole brain approach (Bassett & Sporns, 2017). First, resting state connectomes were created for each subject while controlling for head motion. Brain basis set (BBS) modeling, a multivariate predictive modeling technique, was then used following the procedures outlined by Sripada et al. (2019). In short, BBS modeling involves performing principal components analysis (PCA) on a training dataset; this reduces the number of connections examined, thus minimizing redundancy. This smaller set of components (i.e., basis set) represent the most relevant individual differences in connectomes. From there, an expression score is calculated for each component which is then used as a predictor for the outcome of interest in multivariate regression analysis. The beta weights are saved and then the trained regression model is used on the held out data. Permutation tests and visual inspection of component maps are used to interpret observed associations.

For the current analysis, a total of 75 components were used based on prior work demonstrating the optimal number to fall somewhere between 50 and 100 components; beyond which, overfitting becomes a concern (Sripada et al., 2020). To ensure generalizability and reduce the likelihood of spuriously identified connections, leave-one-site-out cross-validation was used; wherein, for each fold of the cross-validation, data from one of the ABCD testing sites was used as the held-out dataset, and the models were trained using the remaining data. Finally,

the models included commonly used covariates: age, age^2, motion, motion^2, sex, and race/ethnicity.

3.2 Results

Missing Data and Sensitivity Analyses

Given the large proportion of data missing from the sample, an analysis of the missing data was conducted (see Appendix B). Results showed that the two largest missing data patterns were a result of negative affect measures: those with no teacher report form data (39%) and those missing both the teacher report and self-report form data (14%). Further tests revealed that mean differences on the variables of interest (negative affect, impulsivity, and mental health diagnosis) did not differ systematically across those with and without missing data (see Table B1). They did, however, differ on demographic variables. Those with missing data were associated with lower income, parental education and had a higher proportion of Black and Hispanic individuals (see Table B2). Thus, the data was determined to be Missing at Random (MAR; Graham, 2009).

Additionally, sensitivity analyses were conducted (see Table B3) wherein four models differing in the inclusion of teacher report (TRF) and/or youth self-report (YSR) negative affect measures (and thus differing in the number of participants excluded from the analyses due to missing data) were compared. The findings below reflect those from the original model including both the teacher report (TRF) and youth self-report (YSR). Only parameters that were consistently significant across models in the sensitivity analyses are discussed.

3.2.1 Multinomial Logistic Regression

Correlations across all measures used in the analyses are shown in Table 12. Adjusted odds ratios (AOR) and 95% confidence intervals from the multinomial logistic regression

analyses are shown in Table 13. Adjusted odds ratios are considered significant if the confidence interval does not contain the value of 1. Significant values below 1 indicate that higher values on the variable are predictive of membership in the reference group. Significant values above 1 indicate that higher values on the variable are predictive of membership in the comparison group. Descriptive statistics by mental health diagnosis are shown in Table 14.

Impulsivity

The likelihood in being in any of the mental health categories, compared to no MHC, increases as levels of lack of perseverance increase. Higher levels of lack of premeditation were associated with increased likelihood of being in both the externalizing group and the heterotypic group compared to the internalizing group. While levels of impulsivity did not significantly predict the likelihood of being in the heterotypic comorbidity group compared to the externalizing group, higher levels of negative urgency were associated with the heterotypic group when compared to the internalizing group.

Negative Affect

The likelihood of being in the internalizing group, compared to no MHC, increases as levels of anxiety (both TRF and YSR) increase. Likelihood of being in the externalizing group, compared to MHC, increases as levels of anger (both TRF and YSR) and depressive affect (YSR) increase. Compared to internalizing, being in the externalizing group is predicted by higher levels of depressive affect (TRF) and anger (TRF) and lower levels of anxiety (TRF and YSR). Compared to no MHC, the likelihood of being in the heterotypic group increases as levels of anger (both TRF and YSR) and anxiety (both TRF and YSR) increase. Higher levels of anger (TRF) and anxiety (TRF and YSR) also predict heterotypic group membership versus being in externalizing group, while higher levels of anger (TRF) and

depressive affect (YSR) predict heterotypic group membership versus being in the internalizing group.

Gender Moderation

In the full sample analyses, being male was associated with being in either the externalizing or heterotypic groups (compared to no MHC and internalizing). Being female was only associated with being in the internalizing group when compared to the externalizing group. Analyses were re-run for males and females separately to examine gender moderation but none of the AORs differed significantly across males and females.

3.2.2 Brain Base Set (BBS) Modeling

Findings indicated very small, positive associations for each facet of impulsivity: positive urgency ($r = 0.11$, $p < .001$), negative urgency ($r = 0.07$, $p < .001$), lack of premeditation ($r = 0.04$, $p < .02$), and lack of perseverance ($r = 0.08$, $p < .001$). Consensus maps (see Figures 8 and 9), however, indicated that there was a lack of sufficient spatial reproducibility for interpretations to be possible (Tian & Zalesky, 2021). This suggests that each feature of the connectome plays a weak role in the overall small impulsivity associations. Thus, specific impulsivity related networks could not be identified. As such, no further analyses or interpretation were attempted.

3.3 Discussion

The current study utilized a dimensional approach to psychopathology by focusing on the transdiagnostic indicators of negative affect (NA) and impulsivity to examine heterotypic comorbidity and neural correlates in in a pre-adolescent sample from the US national ABCD study. The specific aims of the study were 1) to examine how levels of impulsivity and negative affect vary across dimensions of psychopathology and identify unique combinations that predict

heterotypic comorbidity and 2) to determine whether or not self-reported levels of impulsivity were associated with specific neurological networks and if these neural correlates varied by impulsivity subtype. Using multinomial logistic regression, 4 subtypes of impulsivity (negative urgency, positive urgency, lack of premeditation, and lack of perseverance) and 3 forms of negative affect (depressive affect, anxiety, and anger) were used to predict whether an individual reported having an internalizing disorder, externalizing disorder, or both. Secondly, to gain a better understanding of neurological substrates, brain base set modeling was used to look for neural associations with impulsivity in 9 and 10 year-olds. The first set of analyses demonstrated that comorbidity classifications differed by dimension with those in the heterotypic comorbidity group reporting the highest levels of both impulsivity and NA symptoms. The second set of analyses suggested small, positive, impulsivity related neural correlates, though the small effect sizes and issues regarding reliability took away the ability to draw conclusions regarding specific networks.

Predicting Comorbidity

Adjusted odds ratios from multinomial logistic regression analyses demonstrated several significant differences in negative affect and impulsivity levels between classes of comorbidity: no mental health diagnosis (no MHC), externalizing diagnoses only (EO), internalizing diagnoses only (IO), and those with both an externalizing and internalizing diagnosis (i.e., heterotypic comorbidity; IxE). Those in the EO group were characterized by higher levels of anger, depressive affect, and urgency (compared to IO and no MHC). High levels of lack of perseverance distinguished those in EO from those in no MHC while high levels of lack of premeditation distinguish those in EO from those in the IO group. In addition, those classified as IO were characterized by higher levels of anxiety (compared to EO and no MHC) and lower

levels of negative urgency (compared to IxE) and lack of premeditation (compared to EO and IxE groups). Being in the IxE group was defined by the highest levels of negative affect (higher anger and anxiety than EO and higher anger and depressive affect than IO).

Both IxE and EO group membership was predicted by higher levels of negative urgency and lack of premeditation when compared to the IO group. Negative urgency and lack of premeditation levels did not, however, differ between those in the EO and IxE groups. Together the results show that negative affect and impulsivity are effective trans-diagnostic indicators with nuanced associations emerging when the constructs are broken down into sub-facets. Finally, the models did not differ by gender which is consistent with findings from other studies examining the role of impulsivity and negative affect in the prediction of psychopathology (Johnson et al., 2017; Mahendran et al., 2021; Piko & Pinczés, 2014).

Impulsivity

Higher levels of positive urgency were predictive of being in the externalizing group, compared to the no MHC group. This is consistent with previous studies that have linked positive urgency to externalizing behavior, specifically (Bresin, 2019; Johnson et al., 2013). Unexpectedly, higher levels of lack of premeditation did not differentiate between those with and without a mental health diagnoses. The reasons for this are unclear but it may be simply due to the fact that future oriented thinking is more common at older ages (McCormack et al., 2019) and thus not indicative of dysfunction at this age.

Lack of perseverance was the only impulsivity trait to predict being in all three mental health diagnoses groups when compared to the no MHC group. This was not expected given the amount of studies that find NU to be most strongly associated with psychopathology (Berg et al., 2015; Cosi et al., 2011; Romer Thomsen et al., 2018). However, sensitivity analyses (see

Appendix B) showed that NU only become insignificant when the TRF or both the TRF and YSR NA measures were included. This suggests that NU may not be uniquely associated with psychopathology after controlling for NA, except when comparing those with heterotypic comorbidity to those with internalizing disorders.

Although not as strongly as NU, lack of perseverance has been shown to have consistent positive associations with multiple forms of psychopathology (Berg et al., 2015). Additionally, in a meta-analysis looking at impulsivity and substance use, lack of perseverance had the largest average effect size out of all the impulsivity dimensions (Coskunpinar et al., 2013). That is to say, this dimension of impulsivity – lack of perseverance - is by no means negligible when discussing psychopathology and related behaviors.

Furthermore, lack of perseverance has been conceptualized as an inability to stay focused with links to ADHD specifically (Berg et al., 2015). This explains the link to externalizing conditions, but for internalizing disorders, lack of perseverance may be best thought of in terms of an inability to focus one's attention away from past or irrelevant events, thus resulting in distracting obsessive thoughts (Gay et al., 2008). This definition is very similar to that of rumination, which refers to repetitive negative thoughts about one's self and upsetting experiences (Watkins, 2008), and is highly implicated in the development and worsening of internalizing disorders (Watkins & Roberts, 2020). Finally, others suggest that lack of perseverance reflects a low sense of responsibility or abnormally low levels of positive reinforcement from activities (d'Acremont & Van der Linden, 2007; Magid & Colder, 2007). The former may lead to behavioral issues associated with externalizing psychopathology while the latter may reflect an inability to experience pleasure, akin to the construct of anhedonia (Magid & Colder, 2007; Shankman et al., 2014).

Impulsivity Across Psychopathology Dimensions

Levels of impulsivity did not differentiate between externalizing and heterotypic groups but lack of premeditation was associated with a greater likelihood of being in either when compared to the internalizing group. Additionally, higher levels of negative urgency were predictive of heterotypic group membership over the internalizing group.

The relatively few negative urgency associations were unexpected, however, the majority of existing studies looking at negative urgency do not control for negative affect. Given the large emotional component of negative urgency, it may be that the inclusion of multiple NA measures in the current analyses resulted in insignificant findings. The consistent finding that negative urgency has some of the strongest associations with addictive and psychopathological behavior (Berg et al., 2015; Romer Thomsen et al., 2018; Stautz & Cooper, 2013), suggests that NA may be an important catalyst of impulsive behavior. Alternatively, this pattern of findings may suggest that poor self-regulation of emotion leads to various manifestations of impulsivity (Berg et al., 2015). Given that negative urgency became insignificant with the inclusion of NA, the former implication is most likely.

Negative Affect

As predicted, as self-reported negative affect levels increased, so did the likelihood of having an MHC, regardless of type or comorbidity. Compared to those with no MHC, IO group membership was predicted by higher levels of anxiety, EO by higher levels of anger and, IxE by higher levels of both anxiety and anger. Self-reported depression was only a significant predictor of IxE membership when compared to IO. The fact that depressive affect was not significantly higher in IO individuals, than in no MHC, may be due to the fact that the IO group consisted predominantly of those diagnosed with an anxiety disorder. Additionally, anxiety disorders often

have an early childhood onset, while MDD is more likely to develop later in adolescence (Skodol & Bender, 2008).

Consistent with previous literature, higher levels of anger were reported by those in the EO group. Interestingly, depressive affect was only a significant predictor of EO when reported by teachers. Research shows that high levels of anger and depression are commonly reported by those with externalizing disorders (McDonough-Caplan et al., 2018; Zisner & Beauchaine, 2016). In fact, higher levels of anger and depression are associated with higher levels of behavioral dysfunction while levels of anxiety may act as a buffer, lessening symptom severity (Schatz & Rostain, 2006; Walker et al., 1991).

Other research suggests that heterotypic comorbidity results in more severe symptoms and worse outcomes (Biederman et al., 2008; Daviss, 2008); that is, having an internalizing disorder (including anxiety) and externalizing disorder represents multiple problems, thus resulting in greater overall impairment (Mahendran et al., 2021). The current findings also support this view, with those in the IxE group reporting the highest levels of anxiety and anger. It could be that both the buffer hypothesis and multiple problems hypothesis are correct. That is, subclinical levels of anxiety act as a buffer against behavioral dysfunction, while clinical levels, result in heterotypic comorbidity, and lead to the highest levels of dysfunction.

Self-Report Vs. Teacher Report

In the current study, teacher reported items showed more associations with KSADS diagnoses than youth reported items which may suggest that teachers, as adults, are better at identifying and labeling emotional states than children. All teacher reported negative affect associations overlapped with the youth reported scale scores, except for higher levels of depressive affect predicting being in the heterotypic versus the internalizing group. This makes

sense as sadness and depression may be interpreted as shyness or a quiet demeanor to an outside observer (Mahendran et al., 2021) and more fine-grained differentiation in levels of depressive affect (via self-report) may be necessary for differentiating between those in the heterotypic and internalizing groups. Studies have shown, in fact, that measures of internal states are best as self-report, by the children themselves (Colins et al., 2022; Epkins, 1993; Sauder et al., 2012; Zapolski & Smith, 2013). Relatedly, TRF levels of anger were significant predictors in most instances. As anger is often directed outward through aggression, it is likely much easier to observe than purely internal states.

Negative Affect Across Psychopathology Dimensions

While findings comparing the no MHC group to the other three groups were mostly consistent across YSR and TRF ratings, levels of reported affect differed in significance between informants when comparing the IO, EO, and IxE groups to one another. For the YSR measures, depressive affect was a significant predictor of IxE membership when compared to those in IO. Otherwise, depressive affect levels did not aid in distinguishing between those in the IO & EO groups, or between those in the IxE and EO groups. Those in the IxE and IO groups did not differ on anxiety level, but both reported higher levels of anxiety than the EO group. The IO and EO groups did not report differing levels of depressive affect or anger. Overall, these findings suggest that, when comparing those with diagnoses, heterotypic comorbidity is associated with higher levels of depressive affect than those with one or more internalizing disorders, and higher levels of anxiety when compared to those with one or more externalizing disorders. Those with internalizing and externalizing disorders differed only by level of anxiety, with higher levels being found in those with an internalizing disorder. Self-reported levels of anger did not predict group membership.

Unlike YSR reported levels of depressive affect, TRF levels of depressive affect did not predict membership in IxE when compared to IO. They did, however, predict EO membership when compared to IO. As with the YSR, lower anxiety levels were associated with membership in EO when compared to either IO or IxE. TRF anger ratings, however, suggested that higher levels of anger predicted IxE membership (compared to the IO or EO groups) and membership in EO when compared to IO. The highest level of teacher perceived anger were for IxE, followed by EO, and finally IO had the lowest out of all of those with MHC.

Neural Correlates of Impulsivity

The results of the BBS analyses indicated a small, positive association between resting state functional connectivity and each dimension of impulsivity. Consensus maps indicated that, for each dimension, these associations were widespread and weak. In other words, due to lack of sufficient spatial reproducibility, further interpretations were not possible and there were no unique impulsivity related networks identified. Instead, each feature of the connectome appears to play a weak role in predicting impulsivity.

A recent study also using ABCD data identified unique network features associated with the domains of cognitive performance, personality (impulsivity related), and mental health (Chen et al., 2022). Like the current findings, although significant, the predictive accuracy was especially low for impulsivity related measures. This, along with the current findings, suggests that impulsivity may not be able to be identified at the neurological level in a meaningful way using resting state fMRI data in pre-adolescent samples. However, given that functional brain networks go through substantial reorganization throughout adolescence (Supekar et al., 2009), associations with behavior will become more apparent and stable as environmental exposure to

risk factors accumulate (Birn et al., 2017). Thus, it may be that impulsivity neural correlates are stronger and/or more reliable in older age groups.

Studies have also called into question the reliability of predictive models using resting state functional connectivity (Finn & Bandettini, 2021; Tian & Zalesky, 2021). When using machine learning approaches to understand neural processes linked to behavioral traits, the most useful connections for prediction must be able to be identified reliably. As such, the reliability of the model parameters (i.e., feature weights) are essential. Recent research has shown that, in general, the reliability of these weights is poor, especially when the effect sizes are small, (Tian & Zalesky, 2021), as was the case here with impulsivity dimensions. Thus, the neuroimaging findings here should be interpreted with extreme caution and require validation using external samples. However, as has been suggested in the literature (Tian & Zalesky, 2021), it may be that broad measures of behavioral traits are simply unable to be reduced to one set of distinct connectivity patterns.

Assessing reliability in neuroscience is especially complicated and the field has much more work to do at both the theoretical and practical levels. Conceptually, functional connections in the brain are still unclear. That is, there is no way to know if the reconstructed network actually reflects the true network. As argued by Finn and Rosenberg (2021), this conceptual ambiguity combined with a lack of consistency in measurement, high amounts of measurement error, and inconsistencies in data acquisition and processing, make it unreasonable to expect high levels of reliability and validity between behavior and fMRI data both within and across studies. Furthermore, heterogeneity in brain functioning, both between and within individuals, would necessarily lead to small associations with trait measures, even when they capture the same construct or phenomenon.

Strengths and Limitations

The current study has a number of notable limitations. Firstly, the age range of the sample was limited and the analyses were cross-sectional in nature. Therefore the findings can only describe associations between psychopathology and transdiagnostic indicators, and not yet track developmental changes. Future studies utilizing longitudinal designs are needed as ABCD participants age to better understand developmental trajectories, temporal ordering, and causality.

Relatedly, measurement issues concerning differential functioning by age could not be examined and may have influenced the findings. Emotional awareness is an emotion regulation skill that develops with age (Labouvie-Vief, 2003). Due to less emotional awareness, the validity of self-reported emotional states in children and adolescence may be questionable. While studies show that child and adolescent self-reports of negative affect have weak correlations with parent and teacher reports, studies have also established that self-reports of emotion at these ages are reliable and offer unique information (Achenbach, Ivanova, et al., 2017). In other words, youths' self-reported emotions provide valuable information on their emotional states above and beyond that which can be obtained from teacher or parent reports (De Los Reyes et al., 2015). As such, it is considered best practice to combine data from multiple informants when measuring emotional states at these ages (Kessel et al., 2021), as was done in the current analyses. Still, future measurement studies are needed to ensure validity. This further emphasizes the importance of conducting developmentally focused measurement analyses.

One important limitation is the amount of missing data that was present in the analyses. In the BBS analyses, standard exclusion criteria commonly used in studies utilizing ABCD data were applied (e.g., Sripada et al., 2021), which resulted in the reduced sample size. The first

analysis also had a large amount of missing data. This was due to the fact that listwise deletion methods were necessary in order for the model to run. The main variables responsible for missing data were the NA measures and this resulted in a large reduction in sample size. Despite this reduction in sample size, it was considered the best option as multi-informant measures of negative affect have been shown to function best and provide unique information (Kessel et al., 2021). Still, as shown in the missing data analysis, this elimination of data greatly impacted the generalizability of the findings and they will need to be replicated in more representative samples to improve external validity. Alternatively, future studies could also utilize missing data imputation techniques to avoid relying on complete case analysis (Graham, 2009).

Despite these limitations, the current study has a number of strengths as well. Firstly, the findings here act as a baseline for future longitudinal studies to examine the role of negative affect and impulsivity in the development of psychopathology and substance use. Taking a developmental psychopathology perspective, the current study examined the highly relevant, though understudied, phenomenon of heterotypic continuity and transdiagnostic indicators that contribute to multiple forms of psychopathology (Beauchaine & Cicchetti, 2016). Multiple informant types were able to be compared in the first set of analyses which strengthened NA measurement. The second set of analyses used a whole brain network perspective and advanced machine learning methods to examine neural correlates of impulsivity in the second set of analyses. Future studies may want to incorporate both resting state fMRI and task state fMRI as this combination has been shown previously to work best with the ABCD data (Chen et al., 2022). Finally, the study used a nationally representative, large sample of early/pre-adolescents from the ABCD dataset. ABCD is the largest U.S. study on brain development that includes neuroimaging and longitudinal measures (Karcher & Barch, 2021). These sample characteristics

allow for more confidence in the results of the analyses, and make numerous future follow up analyses possible.

Implications & Future Directions

A reliance on DSM-V categorical diagnoses in psychopathology research greatly obscures understanding of developmental psychopathology. Currently, the criteria for being diagnosed with internalizing and externalizing disorders are independent of one another (Beauchaine & Hinshaw, 2020). As such, the underlying processes that result in the common occurrence of heterotypic comorbidity (i.e. being diagnosed with both an internalizing and an externalizing disorder) cannot be explained using the DSM diagnosis framework. The first aim of the current study was to link DSM diagnoses to trait levels of negative affect and impulsivity, with a focus on the prediction of heterotypic comorbidity. The implications of this are twofold. Firstly, the findings provide a trait level description differentiating those with no mental health condition, those with only internalizing disorders, those with only externalizing disorders, and those with both. Thus, allowing for a dimensional understanding of comorbidity at the trait level. Secondly, the findings link DSM diagnosis categories to a more dimensional conceptualization of psychopathology. As such, past and future research focusing on DSM diagnoses can be better connected to research utilizing a dimensional approach to psychopathology.

Using a dimensional approach also allows for an examination of subclinical levels of these traits. While subclinical levels of psychopathology and related traits have been shown to be associated with several negative outcomes (e.g., Besteher et al., 2020; Crane et al., 2021; Freund & Schulenberg, 2023), direct tests of how these traits influence individuals at the clinical and subclinical levels are needed. For example, recent studies on anxiety suggest that anxiety's association with substance use only reaches a meaningful level at clinical levels of anxiety

(Dixon et al., 2014; Marmorstein, 2012). Future studies may wish to incorporate multigroup analyses to look for quantitative and/or qualitative differences in negative affect across those with and without an official DSM diagnosis.

By focusing on psychopathology indicators in early-/pre- adolescence, at risk youth can be identified earlier than is often the case. In the future, more efficient interventions and treatments can be created to specifically target the most relevant underlying factors by age. As such, the findings from the current study act as a starting point for future, longitudinal studies to build upon. As individuals in the ABCD dataset age, a number of developmental questions can be pursued regarding the measurement invariance of impulsivity and NA, heterotypic and homotypic continuity of psychopathology, associations with risk behaviors, and associated brain development. Furthermore, as participants get older and substance use becomes more prominent, the usefulness of NA and impulsivity at ages 9 and 10 for predicting future substance use can be examined, along with neurological indicators. Despite being unable to examine substance use in the ABCD dataset, previous research has established externalizing developmental pathways ending in high levels of substance use (Beauchaine et al., 2016). For example, high levels of anger and aggression during childhood are related to adolescent substance use (Jester et al., 2008). This suggests that, in the current study, those reporting the highest levels of anger (EO and IxE) are the most at risk for developing substance use issues in the future. Additional analyses as participants age are needed to confirm this pathway and to further test for an internalizing pathway to substance use.

Finally, as shown in the current findings, youth self-report and teacher report measures appear to capture differing aspects of the construct of interest. Future research is needed that includes multiple informants to improve the measure of trait NA in childhood and adolescence.

Conclusions

The current findings suggest that, in pre-adolescence, levels of anger, anxiety, and lack of perseverance are the most useful indicators of psychopathology and can be used to identify heterotypic comorbidity. At the neurological level, impulsivity associations are too widespread to identify specific associated functional networks at this age. An examination of how these findings and associations change as participants age will be an especially useful avenue to pursue for future developmental psychopathology research.

Chapter 4 Adolescent Negative Affect Profiles: Associations With Behavioral, Social, and Substance Use Outcomes

The role of negative affect as a motivation for substance use is still not well understood. While a number of studies have shown that commonly reported reasons for substance use include to cope with negative emotions such as anxiety or depression (Grant et al., 2009), models of internalizing pathways to substance use have shown mixed success in the literature (Behrendt et al., 2017; Broman et al., 2020; Hussong et al., 2017). This may, in part, be due to the use of differing measures of negative affect across studies (most commonly, anxiety or depression), or by studies examining only one form of negative affect at a time. Using a U.S. national sample of adolescents, the current study aims to take a more nuanced look at how trait negative affect is organized and its association with substance use by identifying latent profiles based on trait levels of anhedonia, depression, anxiety, boredom, and anger. The following review will start with a discussion of the structure of affect, generally, followed by a more in-depth look at negative affect: it's subtypes, gender differences, and associations with substance use during adolescence.

Positive and Negative Affect

There is a debate in the literature regarding the structure of affect, with some viewing positive and negative affect as two ends of the same dimension (Moors et al., 2021). However, several studies have shown that affect has a two factor structure, separating into positive and negative emotions (Lan et al., 2021; Watson et al., 1999). Relatedly, numerous studies have shown that measures of positive affect (PA) and negative affect (NA) are only weakly correlated

(Naragon & Watson, 2009) and have differing associations with outcomes (Lan et al., 2021; Thoresen et al., 2003). Thus, low levels of NA should not be thought of as being equivalent to high levels of PA, or vice versa. Instead, both can exist simultaneously at differing levels (Watson et al., 1999) and interact with additional affective dimensions such as levels of arousal or engagement (high or low). Despite mainly focusing on negative affect, the current study uses a measure of low PA (anhedonia) as well. It was chosen for inclusion in the model due to its relevance to depression and psychopathology and because studies suggest that the interaction between levels of NA and PA are especially relevant for understanding emotion-based behavior (Lan et al., 2021).

Anhedonia

Anhedonia is a complex and nuanced construct that is not consistently defined in the literature, at times used synonymously with depression. This is not entirely unwarranted given that depression is characterized in the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) as dysphoric or melancholic, the latter being distinguished by the presence of anhedonia (De Fruyt et al., 2020). Anhedonia is also used to describe multiple internalizing symptoms including loss of pleasure, low positive affect, loss of interest or motivation, loss of anticipatory rewards (or "wanting"), emotional numbing to all affective states, or a restricted range of emotional experiences (Shankman et al., 2014). This makes being able to clearly define and use the construct in analyses difficult, given the lack of consensus on what anhedonia entails. Most generally, however, anhedonia is seen as 1) a loss of or inability to experience pleasure, via either physical or social stimuli, or 2) low positive affect (Shankman et al., 2014).The current study uses the latter conceptualization of anhedonia – i.e., as low positive affect.

Despite being a symptom of depression, anhedonia is not considered a subcomponent of negative affect. This is, in part, due to the fact that anhedonia is sometimes conceptualized as a numbing of all emotional states, both positive and negative. Most often, however anhedonia is defined as a lack of PA (De Fruyt et al., 2020; Shankman et al., 2014). PA is associated with the behavioral activation system (BAS) while NA is associated with the behavioral inhibition system (BIS; Gray, 1990; Lan et al., 2021). The former motivates one to engage in one's environment while the later encourages withdrawal. In these terms low PA/anhedonia could be described as a lack of desire to engage in goal-oriented behavior; similar to "lack of motivation/interest" definitions of anhedonia.

Negative Affect

Negative affect (NA) is used as an umbrella term that encompasses the experience of negative emotions or aversive affective states (Hankin et al., 2016). As an underlying trait, it is defined as the propensity towards experiencing negative emotions and has been linked to both internalizing and externalizing disorders at the clinical level; although, it is considered the core feature of internalizing disorders, specifically (Watson et al., 2011).

Despite often being considered as an all-encompassing latent trait, evidence suggests that NA is multifaceted, with the three most common facets studied being sadness/guilt, fear/anxiety, and anger/irritability (Stanton & Watson, 2014). In the clinical realm, sadness and guilt are associated with depression, while fear and anxiety are linked to both anxiety and depressive disorders (Watson et al., 2011). The anger/irritability factor demonstrates weaker associations with internalizing disorders and may partly explain the association between NA and externalizing behavior (Stanton & Watson, 2014). The current study further examines the multifaceted nature of NA: identifying person-centered patterns of negative affective traits as

they related to adolescent substance use. With person-centered approaches, individuals are grouped into subgroups based on complex patterns of variables. This is in contrast to the more dominant variable-centered approaches that attempt to summarize associations between variables at the population level (Howard & Hoffman, 2018). Given the consistent evidence of gender differences and some evidence of gender moderation in previous studies focusing on substance use and NA (Dawson et al., 2010; Eaton et al., 2012a; Evans-Polce et al., 2018; Farmer et al., 2013), gender moderation of the model is also examined.

Gender Differences and Moderation

Gender differences in internalizing psychopathology are well established, with females representing a larger proportion of those with internalizing diagnoses, and males a larger proportion of those with externalizing diagnoses (Hartung & Lefler, 2019). Gender differences in negative affect at the subclinical level has received relatively limited attention. Using a globally representative data set from more than 150 countries, Zuckerman et al. (2017) found that women reported higher levels of general negative affect than men. However, Fujita et al. (1991) found that gender accounted for only 1% of the variance in self-reported frequency of negative affect, but explained 13% of the variance in reported emotional intensity. Thus, it may be more accurate to say that gender moderates the intensity of an emotion (either positive or negative) rather than the occurrence. Findings on specific negative affect states, however, are still unclear. Despite some mixed findings, females generally report higher levels of anxiety and depression than males (Hartung & Lefler, 2019; Zahn-Waxler et al., 2008). Gender differences in anger have been found in some studies, but overall the literature suggests the absence of significant gender differences in the experience of anger (Fischer & Evers, 2010).

Explanations for gender differences in negative affect include differences in emotional regulation strategies, gender inequalities, social norms and expectations, genetics, and hormones (Batz & Tay, 2018 ; Fischer & Evers, 2010). Women, for example, are found to use more avoidant strategies and rumination to cope with negative emotions, which is shown to be positively associated with levels of negative affect (Thomsen et al., 2005). Men, on the other hand, are more likely to use approach motivated strategies, such as the use of aggression to deal with anger or a threat (Lee & DiGiuseppe, 2018). When examining levels of negative affect across the lifespan, gender differences in rates of clinical anxiety and depression are less prevalent prior to the onset of puberty marking adolescence as the time period during which these gender differences in negative affect begin to emerge (Zahn-Waxler et al., 2008). As such, the current study is interested in gendered patterns of negative affective traits during adolescents, specifically, and their association with substance use.

Moderators of negative affect outcomes have been shown to vary by gender, as well. Leve et al. (2005) found maternal depression to be a predictor of externalizing problems in males, but internalizing problems in females. Conversely, high disciplinary parenting was found to predict externalizing problems in young women but high disciplinary parenting predicted internalizing symptoms in young men. Other variables, such as low self-esteem, are risk factors for internalizing and externalizing problems across gender; the strength of this association, however, varies across males and females (Ybrandt, 2008). Relatedly, studies have shown some psychopathology risk factors to be significant for males, but not females (Walker & McKinney, 2015).Given the existence of gender differences and the evidence of gender moderation, several authors have argued that it is necessary to analyze psychopathology models separately by gender (Crick & Zahn-Waxler; Hartung & Widiger, 1998). If models are not run separately by gender,

the findings are ultimately less valid and less generalizable within individual subgroups (Hartung & Lefler, 2019).

Negative Affect During Adolescence

While not necessarily a time of inevitable "storm and stress" as was once thought (Hall, 1904), emotional lability is characteristic of adolescence, which includes increased emotional intensity, increased reactivity, and more frequent fluctuation between emotional states (Coe-Odess et al., 2019). In addition to feeling emotions more intensely, adolescents report feeling positive emotions less frequently than either children or adults (Rosenblum & Lewis, 2006). Likewise, research shows that levels of negative affect increase during adolescence (Gilbert, 2012; Sallquist et al., 2009).

There are several reasons why adolescents may experience higher levels of negative affect (Coe-Odess et al., 2019). The hormonal changes that occur during puberty, for example, actively influence how adolescents experience emotions, motivation, and levels of stress reactivity and arousal (Coe-Odess et al., 2019; Crone & Dahl, 2012; Garcia & Scherf, 2015). Likewise, several structural neurobiological changes occur during this time, including levels of connectivity between the amygdala and prefrontal cortex (PFC), responsible for emotional experiences and the processing and regulating of emotions, respectively (Spear, 2000b). In addition to neurobiological changes, increased social pressures and maladaptive coping strategies (e.g., substance use) also play a large role in the adolescent emotional experience (Coe-Odess et al., 2019)

Negative Affect and Substance Use

Models and theories regarding the internalizing pathway to substance use are defined by the experience of negative affect. While externalizing pathways to substance use are well

established, and consistent (Colder et al., 2018; Dawson et al., 2010), findings regarding the internalizing pathways are less clear. In studies that do find a significant association, the majority indicate a positive relationship between internalizing symptoms and substance use (Maslowsky et al., 2014; O'Neil et al., 2011). Still, many find negative or nonsignificant associations, especially after controlling for externalizing behaviors (Hussong et al., 2017).

Substance use is attributed to both external and internal influences, with negative affect falling into the latter category. Negative reinforcement models of substance use suggest that substance use is motivated by the desire to cope with NA and are supported by numerous studies that find coping motivations to be strongly associated with substance use (Gillen et al., 2016; Grant et al., 2009). Specifically, substance use is an avoidant coping mechanism wherein one uses substances to avoid (i.e. alleviate) the experience of negative emotions. As posited by social learning theory models (Bandura, 1969), it is this combination of avoidant coping motivations, and a lack of alternative, adaptive coping mechanisms that explains the link between NA and substance use. That is, individuals with a deficit of, or disinclination toward adaptive coping skills, rely on substances specifically to deal with negative affective states. Interestingly, while maladaptive coping is suggested to link all forms of NA to substance use, the consistency of findings regarding a positive NA-substance use association varies widely depending on the individual NA facet being examined (Hussong et al., 2017).

Anxiety. The most commonly studied aspects of negative affect, in relation to substance use, are anxiety and depression. The findings, however, remain mixed and unclear. A systematic review by Hussong et al. (2017) found mainly null findings regarding anxiety and alcohol, marijuana, and illicit drug use, when controlling for externalizing symptoms. There were,

however, some studies that reported associations between anxiety and alcohol and marijuana use, with some reporting positive, and others negative, associations.

The inconsistent findings regarding negative affect and substance use are further complicated by the use of different measures, study designs, and various sample characteristics (i.e. clinical vs. non-clinical samples and the age range of the sample). While evidence for an anxiety-substance use connection in clinical samples is strong, its existence in the general population is less clear (Vorspan et al., 2015), especially when looking at adolescent samples (Freund & Schulenberg, 2023).

A recent study using nationally representative U.S. data from adolescents and young adults found consistently small, positive associations between anxiety and substance use (Freund & Schulenberg, 2023). The strength and significance of this association, however, varied by substance use outcome and developmental stage. Alcohol use and binge drinking showed the weakest effects while marijuana and prescription drug misuse showed the largest effect sizes. Relatedly, effect sizes were stronger, and more consistent in the young adult sample than they were in the adolescent sample. The large sample size used allowed for the detection of small, but consistent, effect sizes thus confirming the presence of an anxiety-substance use association and helping to explain mixed findings in the literature; most studies are underpowered and would be expected to find null results. Finally, the authors conclude that, due to the small effect sizes, the association may be best understood as but one piece of a larger constellation of influences. The current study examines whether other forms of NA are among these relevant variables.

Depression. Multiple studies have shown that both clinical depression and depressive symptoms are predictive of alcohol use and an earlier age of onset in adolescents, even when controlling for externalizing symptoms (Hussong et al., 2017). Positive associations between

depressive symptoms and marijuana and illicit drug use are also relatively consistent across studies. Still, many studies report null findings and a handful report negative association between depressive symptoms and substance use. Overall, depression was most strongly associated with composite substance use and alcohol use, with less consistent positive associations found between depression and marijuana and illicit substance use. Only one article out of 113 reported a negative association between depression and substance use, lending strong support for the existence of a positive depression-substance use association among adolescents, at both clinical and non-clinical levels, and across multiple substances (i.e. alcohol, marijuana, and illicit substance use).

The review by Hussong et al. (2017) however, doesn't fully clarify the negative affect-substance use connection. Firstly, they only reviewed studies looking at the predictive power of negative affect symptoms on later substance use. Instead, when coping motives are involved, negative affect maybe a better predictor of current or past substance use as opposed to future substance use. Since using substances to cope is context dependent, and exacerbated by the experience of stressful events, one's current environment is likely highly relevant. For example, Schlauch et al. (2013) found internalizing symptoms to be more strongly predictive of substance use when parental involvement was low. Finally, in the review by Hussong et al. (2017), the direction of effects varied somewhat by age and gender across studies and composite internalizing scores (anxiety and depression combined) showed less consistent associations than individual facets of negative affect.

Together, the current literature on the association between anxiety and depression and substance use continues to be ambiguous. For each facet, studies have reported positive, negative, and null findings; though, small, positive associations seem to be the most prominent.

Several potential moderators exist that influence this association (e.g., gender, developmental stage, clinical diagnoses vs. trait measures, environmental components, etc.). Most concerning is lack of clarity regarding how negative affect is conceptualized and measured. Differences found in the literature looking at depression and substance use, and anxiety and substance use, specifically, suggest that this association is best considered/examined using individual facets of negative affect. Meanwhile, the small effect sizes found may imply that these facets are of most practical importance when looked at as one, all-encompassing negative affect construct. An alternative explanation is that negative affect facets beyond depression and anxiety are also at play, and combine with one another to create specific and nuanced combinations of negative emotions that make one more likely to engage in substance use. To examine this possibility, the current study uses five facets of affect (anxiety, depression, anger, anhedonia and boredom) to create unique latent negative affect profiles in a nationally representative adolescent sample.

Anger/Irritability. Trait irritability or trait anger (used interchangeably in the literature and in current paper) is a type of negative affect that is experienced in response to an environmental stimulus that is perceived as threatening or blocking one's advancement towards a goal (Dollar & Calkins, 2019). It is a trait that often exists alongside, and shares neurological substrate with, trait impulsivity and anhedonia (Zisner & Beauchaine, 2016). Furthermore, higher rates of trait irritability are associated with both internalizing and externalizing disorders (Zisner & Beauchaine, 2016) including anxiety and depression (de Bles et al., 2019).

Anger differs from other forms of negative affect in that it is associated with approach motivation (Carver & Harmon-Jones, 2009). This association is bi-directional, meaning anger occurs when approach behavior is blocked, or the experience of anger may cause one to approach the source of their anger (Angus et al., 2015). Given this association, it is unsurprising

that anger has been reliably shown to be associated with aggression and externalizing problems (Dollar & Calkins, 2019; Perry & Ostrov, 2018). Anger is also linked to internalizing problems, which are characterized by high levels of negative affect (de Bles et al., 2019).

Studies have found that physical health consequences of anger begin as early as adolescence, and include an increased risk for substance use and abuse (Dollar & Calkins, 2019; Hussong & Chassin, 1994). In fact, studies have shown that dysregulated anger is more strongly related to substance use than other facets of negative affect (McCreary & Sadava, 2000; Pardini et al., 2004). As with depression and anxiety, substance use by anger-prone individuals has been found to be linked to a lack of emotional regulation skills and a desire to cope with levels of negative affect (Dollar & Calkins, 2019; Mischel et al., 2014).

Boredom as Negative Affect

Interest in the construct of boredom has increased in the past few years and, while complex, it is generally defined as an unpleasant state caused by a lack of adequate stimulation (Raffaelli et al., 2017). Studies have shown that both state (temporary, often environmentally induced boredom levels), and trait levels (a chronic propensity to experience boredom) are associated with risk behavior and multiple mental health related variables, including substance use and depression (Freund et al., 2021; Gerritsen et al., 2014; Raffaelli et al., 2017; Vodanovich & Watt, 2016; Westgate & Wilson, 2018). These undesirable outcomes associated with boredom are also seen in adolescent samples wherein prevalence rates of boredom are especially high (Martz et al., 2018).

Boredom is multifaceted, complex, and shows associations with multiple forms of psychopathology. While often associated with sensation seeking (the need for exciting stimuli), it's characteristics also share similarities with other negative affective states. Although not

considered a subcomponent of negative affect in the literature, studies have consistently shown that boredom is distinct from, but strongly associated with, depression (Goldberg et al., 2011; Mercer-Lynn et al., 2011; Vodanovich & Watt, 2016), anxiety (Fahlman et al., 2013), anger and aggression (Dahlen et al., 2004; Mercer-Lynn et al., 2013) and apathy and anhedonia (Goldberg et al., 2011; Mercer-Lynn et al., 2011). When broken down into subtypes, low arousal boredom shares symptoms similar to depression while high arousal boredom shares symptoms related to anxiety and irritability.

Study 1 of this dissertation demonstrated that boredom shares several correlates with the other facets of negative affect, while also maintaining a distinct pattern. For example, like all subfacets of NA, boredom had strong associations with emotional regulation and emotion based impulsivity. Like anger and depression, but unlike anxiety, boredom was positively associated with aggression. Anxiety and depression were both negatively associated with PA, but boredom and anger were not. Like anxiety, but not anger or depression, boredom was positively associated with lack of emotional awareness. Finally, out of all of the NA subfacets, boredom had the strongest positive associations with the behavioral activation system subscales of fun-seeking and drive. This pattern of shared and unique associations suggests a complex relation between these aspects of negative emotionality that require further investigation.

Current Study

The aims of the current study are to 1) create negative affect profiles determined by reported levels of anhedonia, depression, anxiety, boredom, and anger, in a U.S. national sample of adolescents, 2) use membership in these profiles to predict binge drinking, marijuana use, and illicit substance use across grades 8, 10, and 12 and 3) to examine gender moderation in the latent profile model. Although the analyses are somewhat exploratory in nature, categorically

distinct profiles are expected to be found and associated with substance use. Given the lack of guiding evidence in the existing literature, there were no hypotheses regarding details relevant to the make-up of each profile and which, if any, substances would be uniquely associated with each profile. In general, however, higher levels of negative affect are expected to be associated with higher levels of substance use. Due to the mixed findings in the literature, no specific hypotheses were made regarding gender moderation.

4.1 Method

4.1.1 Survey Design

Data for the current analyses come from the Monitoring the Future dataset. MTF is a NIDA funded, national study that aims to track changes in lifestyles, values, and behaviors of youth in the United States with a focus on the prevalence, risk factors, consequences, and patterns of substance use in adolescence and adulthood (Miech et al., 2021; Schulenberg et al., 2021). MTF utilizes a cohort-sequential design, collecting cross-sectional data from approximately 415 public and private schools every year, using in-school surveys. The constructs measured vary across different survey forms which are randomly distributed. Data are included from 2017 through 2019.

MTF uses a three-stage sampling procedure. First, Primary Sampling Units (PSU) based on geographic location are randomly selected. Second, one or more schools from each PSU is randomly selected, and thirdly, a random sample of classrooms is chosen from each of these schools. Only students in grades 8, 10, and 12 are invited to complete the surveys and the annual sample size for each grade is approximately 13,000 to 18,000. For the current analyses, stratum and cluster variables were included to account for the nested nature of the survey design and sampling weights controlled for differential sampling probability.

4.1.2 Sample

The data for the current analyses come from survey forms 2 and 4 of the 4 8th and 10th grade survey forms (approximately 50% of the 8th and 10th grade sample) and forms 5 and 6 of the 6 12th grade survey forms (approximately 33% of the 12th grade sample) from the years of 2017, when anxiety items were first introduced, through 2019. Sample descriptive statistics are shown in the first column of Table 15.

4.1.3 Measures

Anhedonia

Anhedonia was measured using the 2 positively worded items that are often included as part of a 4 item depression scale in MTF (e.g., Maslowsky & Schulenberg, 2013). The findings from the first study showed that these items loaded more strongly with an established anhedonia scale than with an established depression scale. As such, the 4 item scale was split into 2 labeled "anhedonia" and "depressive affect". The anhedonia items are intended to capture the ability to experience pleasure and/or positive affect in life (e.g., "It feels good to be alive"; $\alpha = 0.82$). Response options range from 1(disagree) to 5(agree). These items were reverse coded such that higher scores indicate higher levels of anhedonia and thus a lower ability to experience pleasure.

To confirm the validity of these items, supplemental analyses from study 1 (see Appendix A) looked deeper into the anhedonia items and determined that the MTF anhedonia scale correlated strongly with the HADS anhedonia items, and moderately correlated with the Snaith-Hamiliton Anhedonia Pleasure Scale (SHAPS), a well-established and highly reliable measure of anhedonia (Snaith et al., 1995). Additional convergent validity was found with the items being strongly negatively associated with self-esteem and moderately negatively associated with positive affect measures. It was concluded that these items capture aspects of anhedonia related

to self-esteem and positive affect but may not represent other conceptual definitions of anhedonia (e.g., emotional numbness or pleasure).

Depressive Affect

The depressive affect scale consisted of 2 items ($\alpha = 0.79$) with response options ranging from 1(disagree) to 5(agree). The items are similar to those from the CES-D scale (Radloff, 1977; e.g., "Life often seems meaningless"). In study 1, the items demonstrated moderate to high convergent validity when compared to similar items from the Positive and Negative Affect Schedule (PANAS; Watson & Tellegen, 1985) and the Adolescent Brain and Cognitive Development Study (Jernigan et al., 2018), respectively (see Table 5 and Figures 2 and 6). While at times these items are included as part of a 4 item scale (e.g., Maslowsky & Schulenberg, 2013), study 1 suggested that it was not ideal to combine all 4 items. As such, only the 2 negatively worded items were used to measure depression as has been done with MTF data previously (e.g., Freund et al., 2021).

Anxiety

The anxiety scale consisted of 2 items, “I often feel anxious” and “I worry about how people will react to me”. Response options ranged from 1(disagree) to 5(agree). Together the items have a reliability of $\alpha = 0.66$. The anxiety scale has been used in previous studies (e.g., Freund & Schulenberg, 2023) and both items were successfully validated against the State-Trait Anxiety and Depression Inventory (STADI; Renner et al., 2018) in study 1 (see Table 5 and Figures 2 and 4). The anxiety items from the STADI were specifically engineered to capture anxiety and not the highly related construct of depressive affect. The findings showed that the MTF anxiety items covered an adequate range of theta with discrimination parameters comparable to those of the STADI items.

Boredom

Boredom was measured with 1 item, "I am often bored". Response options range from 1 (disagree) to 5 (agree). This item has been used in previous studies on boredom (e.g., ; Martz et al., 2018) and has been shown to be distinct from the related MTF measures of depression and sensation seeking (Freund et al., 2021). Additionally, in study 1, it performed well when validated against longer, more established scales in the literature (i.e. The Boredom Proneness Scale and the disengagement subscale of The Multidimensional State Boredom Scale; Fahlman et al., 2013; Struk et al., 2017) Conceptually, the item represents disengagement from one's environment, the core feature of boredom (Fahlman et al., 2013).

Anger

Levels of anger are measured with 1 item "I have trouble controlling my temper" with response options ranging from 1(disagree) to 5 (agree). The item is similar to those that make up the anger subscale of the Abbreviated Dysregulation Inventory (ADI; Mezzich et al., 2001). In study 1, the item performed well alongside similar items from the Positive and Negative Affect Schedule (PANAS; Watson & Tellegen, 1985) and the Adolescent Brain and Cognitive Development Study (See Table 5 and Figures 2 and 3).

Demographics

Five demographic variables were included for descriptive purposes and to act as control variables when looking at substance use. They included gender[5] (Male = 1), age (in years), and grade level (8^{th}, 10^{th} or 12^{th} grade). Race/ethnicity was measured with 4 dummy variables (Black,

[5] While MTF includes additional gender options (e.g. nonbinary) in the adult follow up surveys, such options were not available through the 2019 in-school adolescent surveys. As such, only male and female options were available and distinguishing between cisgender, transgender and other identities was not possible.

White, Hispanic, and Other[6]). Highest level of parental education was computed with response options ranging from 1 (less than a high school degree) to 5 (graduate school).

School Achievement and Misbehavior

Academic achievement was measured by asking individuals to report their average grades in school. Response options ranged from 1 (D, 69% or below) to 4 (A, 93% or above). Three items related to school misbehavior were also included. The first asks "during the last four weeks, how many whole days of school have you missed because you skipped or 'cut'?") with response options ranging from 1 (none) to 7 (11 or more). The remaining items ask whether or not an individual has received past suspensions or been held back. Response options range from 1 (no) to 3 (Yes, 2 or more times).

Social Interaction

Four items and one scale were used to examine participants social environment and leisure time activities. The items asked about weekly participation in community affairs, sports/exercise, and the amount of leisure time spent alone in an average week. Response options range from 1 (Never) to 5 (Almost every day). The final single item indicator captures time with friends: "During a typical week, on how many evenings do you go out for fun and recreation? (Don't count things you do with your parents or other adult relatives.)" Response options range from 1 (less than one) to 6 (six or seven).

Parental Involvement. Parental involvement was measured using a scale of 4 items (α = 0.83). These items capture general parental involvement (e.g., "How often do your parents require you to do work or chores around the home") and parental school support (e.g., "How

[6] "Other" included those who identified as Asian, American Indian/Native American, Hawaiian or Pacific Islander, or more than one race/ethnicity.

often do your parents check on whether you have done your homework?). For all 4 items, response options ranged from 1 (never) to 4 (often).

Traits

Sensation Seeking. Sensation seeking refers to the need for stimulation and is associated with impulsivity and substance use. The sensation seeking scale used consisted of 2 items based on Zuckerman et al. (1964) Sensation Seeking Scale (e.g., "I get a real kick out of doing things that are a little dangerous"; $\alpha = .78$). Response options range from 1 (disagree) to 5 (agree).

Self-Esteem & Self-Derogation. The MTF self-esteem (SE; 4 items; $\alpha = .85$) and self-derogation (SDG; 4 items; $\alpha = .89$) scales were used to validate the LPA profiles. The SE (e.g., "I take a positive attitude toward myself") and SDG (e.g., "I feel that I can't do anything right") scales each contain four items with response options ranging from 1 (disagree) to 5 (agree).

In auxiliary analyses from study 1, the SE scale was highly positively associated with positive affect and was moderately to highly negatively correlated with the three anhedonia measures. The MTF SE scale was only weakly or insignificantly associated with other measures of negative affect. The SDG scale was highly positively correlated with depression and moderately correlated with the other types of negative affect. Thus SE levels should be higher in those with low levels of anhedonia and SDG scores should be higher in those with high levels of negative affect.

Substance Use

Three forms of substance use were measured in the current analyses: marijuana use, binge drinking, and drug use other than marijuana[7]. Past 30-day marijuana use was measured

[7] Due to the decrease in cigarette use during adolescence over the past decade, nicotine use was planned to be looked at via levels of vaping; a form of substance use currently growing in popularity and more relevant to today's youth (Miech et al., 2019). However, due to the recency of vaping as a form of substance use, not enough cohorts in MTF had usable vaping related items and vaping was not included as an outcome.

with the question “On how many occasions (if any) have you used marijuana (weed, pot) or hashish (hash, hash oil) during the last 30 days?” Response options ranged from 1 (0 occasions) to 7 (40 or more).

Two of the substance use measures were dichotomized due to low levels of endorsement for some response options; binge drinking and drug use other than marijuana. Binge drinking was measured with the question “Think back over the LAST TWO WEEKS. How many times have you had five or more drinks in a row? (A "drink" is a bottle of beer, a glass of wine, a wine cooler, a shot glass of liquor, a mixed drink, etc.)” Response options ranged from 1 (none) to 6 (10 or more times). For the current analyses, this variable was dichotomized such that 0 indicates no binge drinking episodes and 1 indicates at least one binge drinking episode in the past 2 weeks. Finally, drug use other than marijuana in the past 12 months (OTM) was examined using a dichotomous variable with 0 representing no use in the past 12 months and 1 representing 1 or more occasions.

4.1.4 Analysis Plan

The current analyses use a person, as opposed to variable centered approach. The two approaches are complementary and both are needed to fully understand developmental processes (Laursen & Hoff, 2006). Variable centered approaches aim to describe variables and their associations with one another. This perspective is valuable for determining relative contributions of variables to an outcome of interest. On the other hand, person centered approaches are used to identify subgroups of individuals with common attributes (Laursen & Hoff, 2006). Importantly, variable centered approaches assume that the population is homogenous in how one variable relates to another. Person centered approaches, instead, identify differences in how variables relate to one another, resulting in the identification of subgroups (Magnusson, 2003).

All analyses were run using MLR estimation in Mplus v7.4. Prior to running the LPA, the data were fit to a confirmatory factor analysis model (CFA) to confirm the latent structure of the items being used to capture negative affect. The root mean square error of adjustment (RMSEA), standardized root mean square residual (SRMR), the comparative fit index (CFI) and the Tucker-Lewis index (TLI) were used to determine adequate fit. Per best practices (Masyn, 2013), the LPA analysis was run in multiple stages. These included 1) the enumeration stage (i.e., identify the best fitting model), 2) evaluate model fit and interpret the profile solution, 3) cross-validate the model in an independent sample, 4) validate the individual profiles using covariates, and 5) perform additional covariate analyses of interest. For the final analysis (stage 6), gender moderation was tested.

Stage 1: Enumeration

The aim of the first stage of the analyses, the enumeration stage, was to determine the best number of classes to include in the final model. A set of models specifying 1 to 8-profiles was tested. Models were estimated using 2,500 random sets of starting values with the best 100 solutions used for final stage optimization. These values were doubled and the models were run a second time to confirm that a global maxima had been reached (Masyn, 2013). In each model, indicator means were freely estimated across profiles and were allowed to correlate globally, with values constrained to be equal across profile. Indicator variances were constrained to be equal across profile. Alternative models were run freeing these constrained parameters but they either would not converge or resulted in improper solutions. Next, the best fitting models were compared on absolute fit, relative fit, accuracy of classification, and substantive meaning of the profiles to determine the final model.

Evaluating Model Fit. Several quantitative fit statistics were examined with parsimony, model interpretability, and substantive meaning of individual profiles also influencing final model selection (Masyn, 2013; Nylund-Gibson & Choi, 2018; Spurk et al., 2020). To determine absolute fit, the standardized residuals were examined for values greater than 3, which would indicate a poor fitting model. If a model did not display signs of poor overall fit, relative fit between models were examined using the adjusted Vuong-Lo-Mendell-Rubin likelihood ratio test (LMR-LRT; Lo et al., 2001), which compares the current model to the one comprised of one less profile. Significant LMR-LRT values suggest that the current model is a better fit than the model with one less profile. Additionally the BIC and Sample Size Adjusted Bayesian Information Criterion (SABIC; Schwarz, 1978) was also examined, for which smaller numbers indicate better fit. Similar to SABIC, Aikake's Information Criterion (AIC; Akaike, 1987) was also examined and used to calculate the Consistent AIC (CAIC). The SABIC and CAIC have been shown to be among the most effective indicators for identifying the model that best captures the true parameters of the sample (Nylund et al., 2007). As such, the AIC and BIC values were not influential in selecting the final model and are shown only for transparency, when present, in figures and tables.

Each of the above fit statistics are influenced by sample size (Marsh et al., 2009). With large samples, as is the case in the current study, these indicators may never reach non-significance or a minimum value, thus suggesting the addition of more profiles than necessary. As such, elbow plots (like those used in exploratory factor analysis) of the CAIC and SABIC values were created to aid in selecting the best fitting model (Morin & Marsh, 2015). With these plots, a flattening in the slope indicates the point at which an optimal number of profiles has been reached (i.e., the benefits of including additional profiles are decreasing).

Accuracy of classification for the model as a whole was determined by looking at relative entropy. Though, per best procedures, entropy should not be used to determine the best number of profiles (Lubke & Muthén, 2007). Average posterior class probability (AvePP), and odds of correct classification ratio (OCC; Nagin, 2005) were used to examine profile specific classification accuracy. Entropy and AvePP values range from 0 to 1 with values greater than .70 generally considered indicative of adequate classification (Masyn, 2013). OCC values are the ratio between the odds of correct classification based on the AvePP to the odds of correct classification based on random assignment; OCC values greater than 5 indicate that the model has good class separation (Nagin, 2005). Beyond using quantitative methods, the models were evaluated for clarity, with favor given to models with more parsimony, greater consistency in the classes being identified, and which set of resultant classes made the most sense for understanding NA profiles (Masyn, 2013).

Stage 2: Model Interpretation

When interpreting the models, the NA indicators were examined to determine how well they individually aided in identifying classes. This was done by looking at univariate entropy, latent class homogeneity (i.e., levels of the one specific NA trait epitomize members of at least one latent class in some way), and latent class separation (i.e., the specific NA trait can be used to distinguish at least one latent class from the others; Collins & Lanza, 2013).

Stage 3: Model Validation

It is useful to attempt to validate the model developed on one sample on another independent sample. The same procedures and criteria described above were used to validate the model using the sample from study 1 (N = 753). The sample consisted of young adults (YA), ages 18 to 30 (see Table 1) and identical NA measures were used for profile creation. Model fit

statistics and profile means were compared to those from the MTF model. The model was considered validated if 1) the final YA solution included the same number of profiles as the MTF sample and 2) patterns of NA means were relatively similar across samples.

Stage 4: Profile Validation

To ensure the validity and substantive interpretation of individual profiles, it is recommended to validate the profiles using covariates (Masyn, 2013). Measures of SE and SDG were used as criterion related validity evidence. Mean scale scores of SE and SDG were compared across profiles. Based on the literature and the findings from study 1 auxiliary analyses, SE was chosen as a proxy for positive affect, while SDG represents a construct that is highly related to negative affect. Low self-esteem has been shown to be associated with internalizing disorders in adolescence and young adulthood, especially for those who have comorbid anxiety and depression (Keane & Loades, 2017). High self-esteem on the other hand, is associated with overall mental well-being during adolescence and across the life span. Self-derogation (or negative self-concept) has been shown to be associated with both internalizing and externalizing disorders (Lee & Stone, 2012). In the YA sample, the MTF measures of SE and SDG, along with additional mental health related variables were examined to better validate the NA interpretation of the profiles. These included the STADI, and PANAS-PA[8]. If the profiles are accurately capturing levels of negative affect, lower levels of SE and higher levels of SDG should be found in profiles demonstrating high levels of NA. Likewise, profiles with low levels of NA should report high levels of SE and low levels of SDG.

[8] Measures of anxiety and positive affect, respectively.

Stage 5: Covariate Analyses

After the final model was chosen and validated, a more detailed examination of the differences between groups on covariates of interest was conducted using the R3STEP auxiliary command in M-plus. This method uses a 3-step estimation approach that treats the auxiliary covariates as latent class predictors (Asparouhov & Muthen, 2014; Vermunt, 2010). Here, profile membership was predicted by demographic characteristics, school achievement and misbehavior, social interaction, sensation seeking, and substance use.

Stage 6: Gender Moderation

Multi-group analysis of similarity was used to test for gender moderation in the latent profile model. The steps that were followed are outlined by Morin et al. (2015) and start with a test of configural similarity. In this test, the sample is split by gender and LPA models are run following the same procedures and criteria outlined for the full sample above. Configural similarity in this case refers to whether or not the same number of profiles can be found, with adequate fit, in each group. Next, models were run examining males and females simultaneously to test for structural similarity (the same means within profiles), dispersion similarity (the same variances within profiles), and distributional similarity (the proportion of males and females assigned to each profile is the same). Together, these tests determine how generalizable the latent profile model is across groups and help to identify the nature of any gender moderated differences that are present. This is done by constraining specific parameters to be equal across gender and comparing them to the unrestricted model. Relative fit was determined using the log-likelihood ratio test (*D*). Since the values of *D* are distributed in a way that approximates χ^2, the *D* statistic can be compared to a χ^2 distribution to determine significance.

Prior to running the multi-group LPA, measurement invariance was confirmed (See Appendix B for model fit statistics). Due to the sensitivity of chi-square difference test to sample size, changes in CFI and changes in RMSEA were used to determine invariance. Changes greater than .01 for the CFI and .015 for the RMSEA were considered evidence of non-invariance.

4.2 Results

Following the procedures outlined above, each of the 6 analysis stages are discussed in order below. The findings presented begin (after preliminary measurement analyses) with the enumeration stage and the best fitting profile solution. From there, the final model is interpreted (stage 2), and validated in an independent sample (stage 3). Next the individual profiles are validated (stage 4) and additional covariate analyses are discussed (stage 5). Finally (in stage 6), the findings from the gender moderation analyses are presented.

Preliminary CFA Analysis

Confirmatory Factor Analysis (CFA) was used to confirm the measurement structure. A CFA model allowing the factors to covary fit the data best and thus the covariance structure between indicators was allowed to be estimated in the subsequent LPA models. All items loaded as expected with excellent model fit (RMSEA = 0.028, 95% CI [0.026, 0.031]; SRMR = 0.02; CFI = 0.99; TLI = 0.97). Factor means and correlations are shown in Table 16.

4.2.1 Stage 1: Enumeration

The LPA models converged successfully until the 9-profile solution. Measures of absolute and relative fit are shown in Table 17 and elbow plots for the SABIC and CAIC are shown in Figure 10. Each model fit the data well and showed a significant improvement over the previous model. The 3, 4, and 5 profile models were considered the best candidates due to their

high levels of relative entropy and substantive profiles. The 6, 7 and 8 profile models were discarded in favor of the more parsimonious models displaying adequate fit. Ultimately the 5-profile model was chosen as the final model; the LMR showed a significant improvement over the 4-profile solution ($p < .001$), the model had high entropy, and the resultant profiles made sense, theoretically. Additionally, OCC and average posterior probability values all indicated the model had excellent classification. Indicator means across profiles are shown in Table 18 and classification probabilities based on most likely class membership are shown in Table 19.

4.2.2 Stage 2: Model Interpretation

The standardized means for the final model are shown in Figure 11. Unstandardized means across profiles and individual indicator entropy statistics are shown in Table 18. The largest profile was labeled 'low NA' (n = 28,616; 58%) and reported the lowest levels of anhedonia along with low levels of depressive affect, anxiety, boredom, and anger. The 'moderate NA' profile (n = 12,060; 24%) reported levels of each indicator that were slightly above the sample mean, and the 'high NA' profile reported the second highest levels of anhedonia, along with the highest levels of negative affect (n = 3,645; 7%). The two remaining profiles differed from the others in that reported levels of anhedonia were incongruent with reported levels of other NA facets. The first showed levels of NA similar to that of the moderate NA and high NA profiles, but differed in that they reported low levels of anhedonia, which suggests the presence of positive affect or the ability to experience pleasure. As such, this profile was labeled 'NA+PA' and represented 7% (n = 3,382) of the sample. Conversely, the final profile (n = 1,643; 3%) reported the highest levels of anhedonia, while also reporting the lowest levels of NA; this profile was labeled 'emotionally numb' due to the apparent lack of negative affect and lack of ability to experience pleasure (as indicated by high anhedonia). The qualitative

difference in shape found for the NA+PA and numb profiles support the use of LPA analyses. These groups would not have been captured in variable centered approaches.

Univariate Entropy

Univariate entropy statistics are useful for identifying how much each indicator contributes to latent profile identification. The current model shows that anhedonia (entropy 0.73) and depressive affect (entropy 0.57) are the most useful indicators in the model, followed by anxiety (0.32), boredom (0.29), and anger (0.28). Unlike overall model entropy, there is no specific cut off values for univariate entropy. As described in more detail below, each indicator was useful in distinguishing between at least one pair of profiles and thus no indicators were considered candidates for removal from the model.

The univariate entropy pattern suggests that anhedonia levels are the main influence in profile identification. As shown in Figure 11, anhedonia standardized scores are separated by, on average, 1.25 SD across profiles. The low NA profile reported levels of anhedonia that were 1.25 SD less than those in the moderate NA profile and 2.50 below those in the high NA profile. Anhedonia levels were a defining feature of the numb and NA+PA profiles, wherein levels of anhedonia were incongruent with reported levels of negative affect. The numb profile reported levels of anhedonia 3.0 SD above those reported by the low NA profile, 1.75 SD above the moderate NA profile, and 0.5 SD above those reported by the high NA profile. The NA+PA profile reported levels of anhedonia close to that of the low NA profile.

Depressive affect was the next most effective indicator with an average separation of 1.00 SD across profiles. The numb and NA+PA profiles reported levels of depressive affect closest to that of the low NA and high NA profiles, respectively (approximate difference of 0.35 SD between each).

Anxiety and boredom levels were not particularly useful for determining profile assignment between the moderate NA and NA+PA profiles. These profiles differed from both the low NA and high NA profiles in levels of anxiety by approximately 0.50 SD, and in levels of boredom by 0.25 SD and 0.50 SD, respectively. Anxiety and boredom scores between low NA and high NA profiles were around 1.0 SD apart. Anxiety and boredom levels were most useful for distinguishing between the numb profile and the other three profiles, with numb profile scores ranging from 1.0 to 2.0 SD lower than the others.

Anger was the least effective indicator with an average difference of 0.42 SD across profiles. Anger levels were most useful in distinguishing between the numb profile and the high NA and moderate NA profiles, with the former reporting anger levels approximately 1.0 SD lower than the latter two. Interestingly, unlike anxiety and boredom levels, those in the NA+PA profile reported levels of anger that were closer to those in the high NA profile than those in the moderate NA profile.

4.2.3 Stage 3: Model Validation

The MTF model was validated using the young adult sample from study 1. The enumeration stage indicated that a 5 profile solution best fit the data (see Table 17). This was indicated by the lack of significant LRT values beyond the 5-profile model, good classification across profiles (see Table 19), and a graphical examination of the SABIC and CAIC values (see Figure 12). Standardized means from the final model are shown in Figure 13 and unstandardized means are presented in Table 18. As with the MTF model, anhedonia and depressive affect were the most effective indicators while anxiety, boredom, and anger did not perform as well. The most notable differences were the proportions of participants in each profile. The NA means of

each profile differ slightly across samples but generally share the same pattern. Thus, the 5-profile solution was deemed validated.

4.2.4 Stage 4: Profile Validation

As hypothesized, the highest levels of SDG were found in the high NA profile, followed by the NA+PA and moderate NA profiles (see Figure 14). The profiles with the lowest levels of NA, low NA and numb, had the lowest levels of SDG. Likewise, the profiles with the lowest levels of anhedonia (low NA and NA+PA) also reported the highest levels of self-esteem. Those in the high NA and numb profiles reported the lowest levels of SE. This pattern was found to be identical in the YA sample. In the YA sample, the profiles were further validated with the highest levels of positive affect found in the low NA and NA+PA profiles; the lowest levels were found in the high NA profile. Higher STADI anxiety scores were reported by the high NA profile, followed by the NA+PA profile.

4.2.5 Stage 5: Covariate Analysis

A covariate model was run using a 3-step estimation method. This resulted in a multinomial logistic regression model wherein demographics, socio-environmental factors, and levels of substance use were used to predict profile membership. As it contains the largest portion of the sample, the low NA profile was used as the main reference group (see Table 20).

Adjusted odds ratios (AOR) were calculated in Mplus (see Table 20). Significant AORs are identified by using either a significance test, or by examining the confidence interval (CI); if the CI contains the value of 1, then the AOR is not significant. When interpreting the model, an AOR greater than 1 indicates that, as the value of the covariate increases, so does the likelihood that an individual will be classified as the reference profile (vs. the comparison profile). A

significant AOR *less* than 1 suggests that the likelihood of being classified as the reference profile decreases as the value of the covariate increases. In other words, one is more likely to be classified as the comparison profile (vs. the reference profile) as values of the covariate increase. Results from the significance tests, the calculated AORs, and their confidence intervals are shown in Table 20. Descriptive statistics for the covariates across profile are shown in Table 15.

Demographic Differences Across Profiles

Parental education did not significantly predict classification, although the descriptive statistics show that parental education is skewed to the left (lower levels of education) in the numb group, and to the right (higher levels of education) in the low NA group. Grade level was only significant for one comparison: as grade level increased so did the likelihood of being in the moderate NA versus NA+PA profile (AOR = 1.29).

Age. Age was significantly associated with the high NA profile. For every year that one's age increased, one's likelihood of falling in the low NA profile or NA+PA profile (vs. the high NA profile) increased (AOR = 0.74 and AOR = 1.43, respectively). In other words, as participants aged they were less likely to be in the high NA group.

Gender. The high NA group had more females (68%) than any other group while the emotionally numb group had the most males (65%). More specifically, being female made one more likely to be in the high NA profile compared to the low NA (AOR = 2.41) moderate NA (AOR = 1.58), NA+PA (AOR = 1.95) or numb profiles (AOR = 4.58). Being male increased one's chances of being classified as emotionally numb versus being classified as low NA (AOR = 1.90) moderate NA (AOR = 2.90), high NA (AOR = 4.58) or NA+PA (AOR = 2.35). Additionally, being female increased one's changes of being classified in the moderate (AOR = 1.53) or NA+PA profiles (AOR = 1.24)versus the low NA profile.

Race/Ethnicity. The low NA (51%) and high NA (47%) profiles had the highest proportion of White participants. Black and Hispanic participants had the highest proportions in the NA+PA (16% and 27%, respectively) or numb profiles (25% and 25%). Finally, the largest proportion of those identifying as "Other" [9]were found in the high NA (25%) and NA+PA (22%) profiles. Being Black, Hispanic, or Other was associated with a greater risk of being in the NA+PA profile compared to the low, moderate or high NA profiles. Relative to the low NA profile, being Black increased one's likelihood of being in the NA+PA or numb profiles (AOR = 2.82 and AOR = 1.82 , respectively). Whereas, compared to the low NA profile, being Black made one less likely to be assigned to the moderate NA or high NA profiles (AOR = 0.77and AOR = 0.57 , respectively). Identifying as Hispanic or "other" made one more likely to be classified as NA+PA (AOR = 2.10 and AOR = 2.29, respectively), compared to the low NA group. Identification as Other was also associated with a greater likelihood of being in the high NA profile (AOR = 1.43) compared to the low NA profile. Being Hispanic or Other was associated with an increased likelihood of being in the NA+PA profile than in the high NA profile (AOR = 2.76 and AOR = 1.60, respectively).

Taken together, these findings show that the profiles differ in race/ethnicity and gender, and in the case of high NA, age. The numb profile had the highest proportion of males and Black individuals and the highest proportion of Hispanic and Other individuals was found in the NA+PA and high NA profiles, respectively. Individuals in the high NA group were more likely to be younger females. Parental education, did not influence profile membership.

[9] Asian, American Indian/Native American, Hawaiian or Pacific Islander or more than one race

School Related Differences Across Profile

As average high school grade increased, so did the likelihood of being classified as low NA, versus any of the other three profiles (see Figure 15). Cutting class did not significantly influence profile classification. As the number of suspensions increased, however, so did the likelihood of being classified as emotionally numb versus low NA (AOR = 2.22), moderate NA (AOR = 1.80), high NA (AOR = 1.84), or NA+PA (AOR = 1.93). Increased suspensions were also associated with a greater likelihood of being in the moderate NA profile compared to the low NA profile (AOR = 1.23). Being held back was only associated with an increased likelihood of being in the NA+PA group compared to the low NA (AOR = 1.63) and high NA (AOR = 1.54) profiles. In sum, higher grades were associated with low NA, suspensions were associated with the numb profile, and being held back was associated with the NA+PA profile.

Social Interaction

As the number of times out per week, and the frequency of sports participation increased, so did the chances of being classified as low NA vs. moderate NA (AOR = 0.85 and AOR = 0.86, respectively) or high NA (AOR = 0.73 and AOR = 0.77, respectively; see Figure 16). Likewise, as the amount of solitary leisure time increased, so did the likelihood of falling in the moderate NA or high NA profiles (vs. low NA; AOR = 1.11 and AOR = 1.27, respectively). These variables did not significantly influence the odds of being classified as emotionally numb (vs. low NA) at $p < 01$. Increases in parental involvement, however, increased the chances of being classified as low NA, versus emotionally numb (AOR = 0.39), moderate NA (AOR = 0.65), or high NA (AOR = 0.46).

More times out without a parent per week were associated with a greater likelihood of being in the NA+PA, numb or low NA profiles (vs. moderate and high NA profiles). Relatedly,

increases in solitary leisure time increased the likelihood of being in the high NA profile versus low NA (AOR = 1.31), moderate NA (AOR = 1.18), NA+PA (AOR = 1.22), or numb (AOR = 1.58) profiles. Increased solitary leisure time was also associated with a greater likelihood of being in the moderate NA profile, versus the low NA profile (AOR = 1.11) but did not differentiate between the numb, NA+PA and moderate NA profiles.

Greater sports participation was associated with a greater likelihood of being in the low NA profile, compared to the moderate NA (AOR = 0.85), high NA (AOR = 0.75), or NA+PA profiles (AOR = 0.88). Levels of sports participation did not differentiate between those in the low NA and numb profiles. Higher levels of sports participation were, however, associated with increased likelihood of being in the numb profile versus the moderate NA (AOR = 1.19) and high NA (AOR = 1.34) profiles.

Higher levels of parental involvement were associated with a greater likelihood of being in the low NA group compared to the moderate NA (AOR = 0.63), high NA (AOR = 0.42), NA+PA (AOR = 0.77), and numb (AOR = 0.40) profiles. Parental involvement levels did not predict membership between the numb and high NA profiles, the two profiles with the lowest reported parental involvement. As levels of parental involvement increased, so did the likelihood of being in the low NA, moderate NA, or NA+PA profiles versus either the high NA or numb profiles.

In sum, those in the low NA and NA+PA profiles went out during the week the most while those in the moderate and high NA profiles had the greatest amount of solitary leisure time. Those in the low NA and numb profiles had the highest amount of sports participation. Those in the numb and high NA profiles reported the lowest levels of parental involvement while those in the low NA profile reported the highest levels.

Sensation Seeking

The highest levels of sensation seeking were reported by those in the NA+PA profile (M = 3.80, SD = 1.00) and the lowest by those in the numb profile (M = 1.28, SD = 0.69). As levels of sensation seeking increased the likelihood of being in the numb profile decreased drastically compared to the low NA (AOR = 0.01), moderate NA (AOR = 0.01), high NA (AOR = 0.01), and NA+PA (AOR = 0.00) profiles (see Figure 15). Likewise, higher levels of sensation seeking were associated with a greater likelihood of being in the NA+PA profile compared to the other four profiles. Sensation seeking levels did not differentiate between those in the low NA and high NA profiles, but both low NA and high NA profile membership was associated with higher sensation seeking levels when compared to those in the moderate NA profile (AOR = 1.09 and AOR = 1.12, respectively).

Substance Use

The low NA group reported the lowest levels of 30-day marijuana use, 2-week binge drinking, and 12-month OTM (see Figure 17). The highest proportion of those participating in past 2 week binge drinking was found in the high NA group (12%), followed by the NA+PA profile (11%), moderate NA (10%), emotionally numb (9%), and low NA (7%) profiles. Levels of marijuana use were highest in the high NA (M = 1.58, SD = 1.40) and NA+PA (M = 1.57, SD = 1.46) profiles while those in the low NA profile reported the lowest levels of marijuana use (M = 1.29, SD = 1.02). Past 12-month OTM use was also lowest in the low NA group (6%) and highest in the high NA profile (19%). Average NA, NA+PA, and numb profiles report levels in between; 11%, 11%, and 9%, respectively.

Binge drinking significantly predicted group membership in only one instance: as past 2-week binge drinking increased, the likelihood of being in the high NA profile versus the low NA

profile increased (AOR = 1.54). Likewise, as levels of 30-day marijuana use increased so did the likelihood of being in the numb (AOR = 1.38) or high NA (AOR = 1.13) profiles (versus the low NA profile). The low NA group had the lowest proportion of individuals reporting past 12-month substance use (other than marijuana) at 6%. As OTM increased, so did the likelihood of being classified into either the moderate NA (AOR = 1.64), high NA (AOR = 3.00), or numb (AOR = 2.66) profiles (but not the NA+PA profile). Higher levels of OTM use predicted membership in the high NA profile when compared to the low NA (AOR = 0.33), moderate NA (AOR = 0.55), and NA+PA (AOR = 0.42) profiles. OTM levels did not significantly differentiate between the numb and high NA profiles. Together, the findings somewhat supported the hypothesis that individuals with high levels of negative affect would have greater levels of substance use.

4.2.6 Stage 6: Gender Moderation

As outlined by Morin et al. (2015) multi-group analysis of similarity was used to test for gender moderation in the latent profile model. Prior to model estimation, measurement invariance was confirmed at the configural, metric, and scalar levels. A series of models was run for males and females with 1 to 8 profiles (see Table 21). All models converged except for the 8-profile model for males.

Results show that a 5-profile solution was appropriate for both males and females. As with the full sample model, the 3 and 4 profile solutions were also good candidate models. A visual examination of the SABIC elbow plots suggested either a 3 or 5 profile model was best for females and a 3 or 6 profile model was best for males. Ultimately, the profiles in the 5-profile solution made the most sense theoretically and were the most consistent with the full sample model; thus the 5-profile solution was retained for both the male and female sample and configural similarity across males and females was confirmed.

Next, to test for structural similarity, within profile means were constrained to be equal. This model resulted in worse fit indicating that the models are not structurally similar across gender. As structural similarity is required to test for dispersion similarity (Morin et al., 2015), these models were not run and next distributional similarity was tested. This was done by constraining profile probabilities to be equal across gender. This resulted in significantly worse fit and thus, only configural similarity was confirmed across gender (see Table 22).

Figure 18 shows the standardized profile means for the multigroup 5-profile solution and the unstandardized means are shown in Table 23; classification statistics are shown in Table 24. As expected based on the full sample covariate analysis, a higher proportion of females (versus males) were found in the moderate NA, high NA, and NA+PA profiles. A higher proportion of males were in the low NA and numb profiles.

An examination of Figure 18 suggests that despite having similar profiles emerge, males and females differed, in almost all groups, on levels of anxiety. Each profile, except for NA+PA, showed higher levels of anxiety in females than in males despite falling in the same NA profile. On other indicators, even if the difference was small, females usually reported higher levels of NA than males in the same profile. Exceptions include males reporting slightly higher levels of anger in the low NA profile, and slightly higher levels of anhedonia in the numb profile. Due to this lack of structural equivalence, further gender moderation analyses could not be performed. Together, the findings on gender moderation suggest that NA profiles differ by gender and that this is mainly due to the higher levels of anxiety found for females in the majority of profiles.

4.3 Discussion

Negative affect (NA) is a core feature of internalizing disorders and it is also associated with externalizing behaviors and substance use(Bravo et al., 2020; Stanton & Watson, 2014).

Despite this, direct links between internalizing disorders and substance use are ambiguous (Hussong et al., 2017), and measurement problems abound. The current study was designed to provide clarity regarding the internalizing pathway to substance use in adolescence by incorporating an in-depth examination of NA subfacets and gender moderation. Using a U.S. nationally representative samples of 8th, 10th, and 12th graders, the specific aims of the current study were 1) to identify and validate profiles of negative affect in adolescence, 2) to identify behavioral, environmental, and substance use associations with profile membership and 3) to examine moderation by gender. Gender is often overlooked, or exists as an afterthought, in psychopathology measurement research; this can lead to bias and less efficient strategies for prevention and intervention (Hartung & Lefler, 2019). The final model included five profiles labeled low negative affect (low NA), moderate negative affect (moderate NA), high negative affect (high NA), high negative affect with low anhedonia (NA+PA), and numb (low negative affect and high anhedonia). These profiles were mostly defined by levels of anhedonia (conceptualized here as lack of positive affect) and depression; anxiety, boredom, and anger levels, did not differentiate as well among profiles. The model was successfully replicated in an independent smaller sample providing further evidence of validity. Several demographic, behavioral, school related, and socio-environmental variables significantly predicted profile membership. The highest levels of substance use were found in the high NA profile and the lowest levels of substance use were found in the low NA profile. Configural similarity was established across gender but structural and distributional similarity was not present. That is, males and females both had five profile solutions that fit well, but the means and proportions of each profile differed by gender.

Negative Affect Indicators

Indicators of anhedonia and depressive affect were by far the most influential profile indicators which emphasizes the importance of these facets when looking at negative affect. Surprisingly, levels of anxiety had low levels of univariate entropy indicating it was not an efficient profile indicator. A single item measure of boredom was included and performed similarly to anxiety as a profile indicator. Anger was also measured with one item and it performed the worst as an indicator.

These findings suggest that anxiety, boredom, and anger may not be useful indicators of negative affect among teens. Boredom, for example, despite being associated with both depression and anxiety, may be too common during adolescence (Martz et al., 2018), occurring often for those with and without high levels of negative affect. Alternatively, despite the anxiety, boredom, and anger items being validated against more established scales in study 1, more, or better performing items may be needed to capture these facets of NA adequately. The anger item (i.e., "I have trouble controlling my temper"), in particular, may be picking up on aspects of emotional regulation as opposed to the propensity to experience anger.

Depressive affect, anxiety, boredom, and anger all existed at consistent levels across profiles. This speaks to the strong association between these variables and suggests that they are all connected by an underlying negative affect factor. As such, the inclusion of the construct of boredom in future negative affect research is warranted. Anhedonia levels were consistent with the other indicators only part of the time. This suggests that anhedonia is related to, but not the same as, negative affect. This is consistent with other studies that have shown positive and negative affect are separate constructs and not simply two ends of the same dimension (Diener & Emmons, 1985; Gilbert, 2012; Watson et al., 1999).

Negative Affect Profiles

The low, moderate, and high profiles reported low, moderate, and high levels of both negative affect and anhedonia, respectively. Differences in shape emerged for the latter 2 profiles. The NA+PA and numb profiles had levels of anhedonia incongruent with the other four NA indicators; the numb profile with high anhedonia and low NA, and the NA+PA profile with low anhedonia and high NA. These qualitatively distinct profiles (i.e. differing in shape as well as level) suggest that person-centered approach, as was the focus of the current study, is more appropriate when studying negative affect.

The profiles found are similar in positive and negative affect levels to those described in affective temperament theory (ATT; Norlander et al., 2002). This theory categorizes people based on the interaction between positive and negative affect levels resulting in 4 categories: self-fulfilled (high PA, low NA), self-destructive (low PA, high NA), low affectivity (low PA, low NA), and high affectivity (high PA and high NA). In the current study, defining anhedonia as lack of positive affect, these correspond with the low NA, high NA, numb, and NA+PA profiles with the moderate NA profile emerging as an additional group with moderate levels of both positive and negative affect.

Model Validation

The negative affect means of each profile differ slightly across samples, but generally share the same pattern, and thus the model was successfully replicated in an independent sample of young adults. This allows for greater confidence in the 5-profile solution. The numb profiles appear to deviate the most with the MTF sample reporting more extreme values; anhedonia means are higher and the anxiety, boredom and anger means are much lower than those reported by the YA sample. Although beyond the scope of the current analyses, it may be that the make-

up of NA profiles changes with age. This would make sense given the increased ability to identify and regulate emotions that comes with age (Casey et al., 2019). Future studies using the MTF follow up data can be used to test for moderation by developmental stage (adolescence vs. young adulthood), and longitudinal analyses examining transitions in profile membership over time would be valuable.

Gender Moderation

In the main LPA analysis, there was a large gender imbalance in the numb and high NA profiles. The former comprised of approximately 2/3 males and the latter 2/3 females. Similar gender ratios were found in the validation sample. Gender was evenly divided in the low NA and NA+PA profiles, with a slightly higher percentage of females (vs. males) found in the moderate NA profile. In moderation analyses, male and female samples both fit the 5-profile solution well. However, the structure of the profiles differed, with females consistently reporting higher levels of NA, especially anxiety, than males categorized in the same profile. This fits in with the previous literature showing females report higher levels of negative affect and suffer disproportionately from anxiety disorders (Bandelow & Michaelis, 2015; Eaton et al., 2012b).

Based on previous findings, the greater proportion of females in the high NA profile is not unexpected, but reasons for the large proportion of males in the numb group is not immediately clear. One of the main characteristics of the numb profile was very high levels of anhedonia and, in general, men are worse at identifying emotions and express emotion less often than females (Jansz, 2000). Thus, the lack of emotions reported may represent deficits in emotional awareness.

Another possible explanation may be early life adversity (ELA). Developmental studies have shown that prolonged exposure to stress in childhood predicts later levels of anhedonia.

This is suspected to be due to changes in the stress and reward systems of the brain as a results of ELA (Prabhakar et al., 2022). There is evidence from animal models suggesting that this type of emotional suppression and reward seeking deficit is a defense mechanism used more often by males than by females. Females, instead, often respond to ELA in the opposite direction; with enhanced motivation to obtain rewards (Birnie et al., 2022). Thus, it's possible that the numb and high NA groups, dominated by males and females, respectively, may represent (or at least include) differing neuro-affective responses to ELA, stress, and/or trauma during childhood. This is beyond the scope of the current study and will need to be clarified in future research.

Covariate Analyses

Demographics

Race/ethnicity and age were also significant predictors of profile membership. Age was only significantly associated with high NA membership wherein being younger made one more likely to be classified as high NA vs. low NA or NA+PA. Grade level and parental education were not significantly associated with profile membership.

Identifying as Hispanic or Black was associated with a greater likelihood of being in the NA+PA or numb profiles, while identifying as Other made one more likely to be classified as high NA or NA+PA. This latter finding, in particular, supports previous findings that minority youth, especially those who identify as Native American, Pacific Islander, or more than one race/ethnicity (labeled as "Other" in the current analyses) have higher levels of negative affect and internalizing symptoms than their Caucasian counterparts (Asdigian et al., 2018; Carlton et al., 2006; Hishinuma et al., 2004).

School Achievement and Misbehavior

The low NA profile reported higher grades than any of the other profiles. This finding supports other studies that have found higher levels of negative affect to be negatively related to student grade point average (Gumora & Arsenio, 2002). Negative affect is thought to influence academic achievement indirectly via negatively impacting motivation and executive functioning (Valiente et al., 2012). Grades did not, however, differentiate between any of the remaining four profiles.

A greater number of suspensions predicted membership in the numb profile when compared to any of the other four profiles. There is some evidence that students experience anger and depression in response to being suspended (Cottrell, 2018), but this does not indicate a general proclivity towards negative affect. It is perhaps more likely that this is a spurious association. The numb profile also had the highest proportion of Black and minority students. Thus the higher suspension rates may be best explained by fact that Black and minority students are disciplined more often and more harshly than their White counterparts (Camacho & Krezmien, 2020).

Parental Involvement

The low NA profile reported the highest levels of parental involvement, higher levels of which have been shown to be associated with better academic and emotional functioning during adolescence. Using depression levels and GPA as outcomes, higher levels of parental involvement during adolescence were associated with more desirable outcomes (Wang & Sheikh-Khalil, 2014). In the current study, the lowest levels of parental involvement were reported by the high NA and numb profiles with the NA+PA and moderate profiles reporting levels in between.

Social Interaction

The current analyses examined active and solitary leisure activities. Higher levels of the former made one less likely to be classified as high NA, while higher levels of the latter increased ones likelihood of being classified as high NA.

Sports Participation and Exercise. The low NA profiles reported the highest levels of sports participation and exercise. This is in line with recent findings reported by Badura et al. (2021). Researchers found that engagement in organized leisure-time activities, especially organized sports participation, was positively related to adolescent's well-being including fewer psychological problems and better self-rated health. These findings held regardless of age, race/ethnicity, sex, socioeconomic status, or country. This universal association, however, does not aid in explaining the relatively high rates of sports participation/ exercise reported by those in the numb and NA+PA profiles. Although beyond the scope of the current study, it seems likely that a more nuanced look distinguishing between formal sports participation, casual sports participation, and general exercise would clarify this discrepancy. For example, (Donaldson & Ronan, 2006) found formal/organized sports participation to be more negatively associated with social and behavioral problems during adolescence than more casual activities.

Socializing & Solitary Leisure. Low NA and NA+PA reported the most times out without a parent per week. While the high NA group reported, by far, the least. Instead, the high NA profile reported the highest levels of solitary leisure. These findings suggest the detrimental nature of solitary leisure time during adolescence, a time period during which one is wired to be more socially oriented (Casey et al., 2019).

Studies show that solitary leisure is not always negative and is only harmful if done in excess. Additionally, studies show that the type of activity in which one engages during time

alone is an important mediator (Passmore, 2003). For example, Hipson et al. (2021) found that passive and active activities (e.g., watching tv and engaging in hobbies, respectively) were not detrimental to adolescent well-being. Time alone spent thinking, on the other hand, was associated with poorer mental health. The authors suggest this is likely due to rumination, (i.e. dwelling on negative thoughts or events), an emotional regulation strategy linked to internalizing traits and disorders such as clinical anxiety and depression.

Sensation Seeking

Low, moderate, and high NA profiles all reported similar, moderate, levels of sensation seeking while the NA+PA profile reported the highest levels and the numb profile the lowest. Thus, along with high levels of NA and low levels of anhedonia, the NA+PA profile is further distinguished by high levels of sensation seeking. Likewise, along with low levels of negative affect, and high levels of anhedonia, the numb profile is also characterized by low levels of sensation seeking.

Given the amount of literature identifying sensation seeking as a strong and consistent predictor of substance use (Evans-Polce et al., 2018; Hildebrandt et al., 2021), it is somewhat surprising that the NA+PA profile did not report the highest levels of substance use. Likewise, the numb profile did not report the lowest levels of substance use. Instead, the highest levels of binge drinking and OTM were reported by the high NA group and the lowest by the low NA group.

Substance Use

30-Day Marijuana Use. Compared to the low NA profile, membership in the high NA and numb profiles was predicted by higher levels of MJ use. Interestingly, levels of MJ use did not differentiate between the low NA and NA+PA profiles, despite the latter reporting the

highest levels of sensation seeking. The higher frequency of use in the high NA profile supports previous findings that MJ use is associated with higher levels of negative affect (Chabrol et al., 2012; Freund & Schulenberg, 2023; Williams et al., 2021). While the numb and high NA profiles reported the lowest and highest levels of negative affect, respectively, they both reported high levels of anhedonia. Thus, if looking at negative affect alone, one might not find a significant association between MJ use and NA. Instead, anhedonia or lack of positive affect may be a more useful indicator. Supporting this idea, Patrick et al. (2016) found MJ use, while not associated with negative affect, did have a negative association with positive affect in young adults.

Past 2-week Binge Drinking Episodes. Previous studies have reported mixed findings when it comes to the association between negative affect and alcohol consumption. Both anxiety and depression are often found to be predictors of alcohol use in young adulthood, but during adolescence there are conflicting results (Hussong et al., 2017; Patrick et al., 2011). Studies show that, while anxiety and depression can be a risk factor for substance use, it may also serve a protective function during adolescence (Hussong et al., 2017). Thus, both the presence of a significant NA-alcohol use association, and the direction of this association is still debated.

The current findings are in line with studies that report a significant, positive association between NA and substance use (Frojd et al., 2011; Welsh et al., 2017). Binge drinking only significantly predicted profile member ship between the two extremes of the NA profiles (high NA and low NA). The small proportion of the sample that made up the high NA profile suggests what others have found: high levels of NA may only be associated with alcohol use and binge drinking when present at extreme levels. The equally large NA+PA profile reported the second highest rates of substance use, but not high enough to differ significantly from the low NA

profile on any of the substance use outcomes. Thus, it also may be that many previous studies have not had large enough sample sizes to detect this effect/subgroup.

Substance Use Other Than Marijuana (OTM). Higher levels of OTM did, however, predict membership in the high NA profile when compared to any of the other profiles, other than numb, resulting in some of the largest effect sizes found in the model. This finding suggests that high NA, when coupled with low PA, is a strong predictor of less common forms of substance use. These findings corroborate those from previous studies that have found various forms of negative affect to be associated with prescription drug misuse and illicit substance use (Freund & Schulenberg, 2023 ; Welsh et al., 2017) and those that show internalizing disorders are often comorbid with substance use disorders (Vorspan et al., 2015).

Positive and Negative Affect Substance Use Associations

The findings here suggest that an internalizing pathway to substance use does exist, including for binge drinking and MJ use, with especially strong effect sizes found for substance use other than marijuana. The findings demonstrate, however, that high levels of negative affect alone are not enough to explain the internalizing-substance use association found in the literature. Instead, levels of negative affect appear to interact with positive affect/anhedonia (high and low levels, respectively) to result in higher substance use rates. Furthermore, the current results suggest that high levels of positive affect (as indicated by low anhedonia) present in both the low NA and NA+PA groups may be protective against substance use, even when high levels of sensation seeking and negative affect are present. Although not tested here directly, this is an important avenue to explore in the future and it is in line with other literature that has emphasized the need to examine the interaction between PA and NA, as opposed to examining them individually (Cahir & Thomas, 2010; Gilbert, 2012; Lan et al., 2021).

Strengths and Limitations

A number of limitations of the current analyses should be noted. Based on auxiliary analyses, the definition of anhedonia is limited here to lack of positive affect. Despite showing a strong association with the HADS anhedonia items, the MTF items showed only a moderate association with the SHAPS, a highly reliable measure of anhedonia. Thus, the items' ability to capture 'lack of pleasure' or 'emotional numbness' is still unclear. Furthermore, the definition of anhedonia used here refers to a trait and does not necessarily represent clinical definitions or symptoms. In clinical definitions, anhedonia specifically refers to the loss of interest or pleasure in things that one previously found pleasurable. Trait anhedonia, however, describes a consistent trait characterized by a lack of interest or deriving little to no pleasure from things that most people would find pleasurable (Shankman & Gorka, 2015). This is just one example of the many nuances in how anhedonia is used and defined. Further research is needed to clarify the exact nature of the construct and its derivatives, in general. More specifically, the items from the MTF dataset require further examination to validate the label of "anhedonia" assigned to them in the current studies. Thus, findings here can only be compared to other studies that use the same narrow definition of anhedonia (i.e., low positive affect).

Additionally, the measures for the current study represent broad trait level constructs and are not able to speak to diagnoses or clinical levels of negative affect. Despite MTF having brief measures, all items used were validated in study 1 against longer, more established scales which allows for greater confidence in the results.

There are also inherent limitations regarding the sample and methodological design. Firstly, the data used are cross-sectional and conclusions regarding causation cannot be made. Despite being nationally representative of US students, the use of in school surveys by MTF

excludes part of the US youth population. Specifically, individuals who are homeschooled, absent, or have dropped out are not represented. This, in turn, likely results in conservative estimates of substance use (Miech et al., 2022). Relatedly, the sample is not representative in terms of age due to the focus on 8th, 10th, and 12th grade. That it, ages in between these grade levels are not as well represented.

Finally, the data used are self-report and are thus subject to several well-known limitations of self-report data, including bias. In the current study, for example, it may be that the numb profile was contaminated by careless responders or straight-liners. Straight lining is a type of response bias that occurs when respondents choose the same answer (or close to it) for all items, and it greatly reduces the quality of the data (Kim et al., 2019) . Mixed valence items (i.e. positively and negatively worded items measuring the same construct) are sometimes used to detect this practice (Wetzel et al., 2016). In the current analyses, item wording confounded the depression/anhedonia items so it is unknown whether the patterns found in the NA+PA and numb profiles are indicative of response bias, or if they are truly capturing qualitatively distinct affective profiles. Although straight lining could not be ruled out as a possibility, the profiles were validated in an independent sample in which participants were removed if they displayed evidence of straight lining. Furthermore, MTF data undergo a rigorous data cleaning process in an attempt to greatly reduce this type of contamination.

Despite these limitations, there are a number of notable strengths and important implications. Along with the dimensions of anxiety, depression, and anger, this study is one of the first to use boredom as a facet of negative affect and the findings suggest it would be a useful indicator to use in the future. A growing body of literature has already identified boredom as a construct of interest during adolescence (e.g., Martz et al., 2018); the findings here confirm this

and suggest it would useful to include in studies on negative affect, more generally. Relatedly, by examining NA at the sub-facet level, a more comprehensive look at NA was possible. Furthermore, by including a measure of low positive affect (anhedonia) the influence of both NA and PA were able to be captured by the profiles and examined simultaneously which proved to be key for understanding substance use associations. Thus, a potentially key moderator of negative affect in the internalizing pathway to substance use has been identified, though, future studies are needed to confirm these findings.

An additional strength of the study was the implementation a relatively new procedure for identifying similarity in LPA models across subgroups. This allowed for tests of gender moderation to be conducted, which are generally lacking in the psychopathology literature. This oversight leads to biased conclusions and less effective intervention and prevention strategies (Hartung & Lefler, 2019). The current gender findings suggest that, although similar, negative affect profiles in young men and women are qualitatively different due to reported anxiety levels. This supports the notion that affective processes and psychopathology during adolescence cannot be assumed to be invariant by gender. Additional studies are needed to further explore the implications of this finding and whether it extends to additional gender identities. Finally, the use of a National U.S. sample and the ability to replicate the model in an independent sample increases the generalizability of the 5-profile solution. Finally, capitalizing on the strength of survey data, the breadth of associations able to be tested with the covariate analyses allowed for a more complete picture of each profile.

Conclusions

The current study adds to the literature on negative affect (NA), gender moderation in psychopathology symptoms, and internalizing pathways to substance use during adolescence.

Levels of negative affect (anxiety, depression, boredom, and anger) and low positive affect (anhedonia) resulted in a 5-profile solution that was able to be replicated in a separate sample. Of these profiles, 2 differed in shape while 3 differed in level. The combination of high NA and low PA resulted in the highest levels of substance use, especially for OTM. Meanwhile, high levels of PA appeared to act as a buffer between high levels of NA and sensation seeking and substance use in the NA+PA profile. This suggests low positive affect, or anhedonia, may be a key moderator in the internalizing pathway to substance use and should be included in future NA research. That being said, future research is needed to clarify the definition and measurement of anhedonia. Finally, identifying additional moderators (e.g., age) will be critical in order to fully chart internalizing pathways to substance use.

Chapter 5 Discussion

Adolescence and the transition to adulthood is a time of heightened vulnerability to a number of biological and environmental influences, both positive and negative (Casey et al., 2008; Schulenberg et al., 2004). While, for the most part, characterizations of adolescence as a time of emotional turmoil are greatly exaggerated, levels of negative emotionality and impulsive behavior do increase during this developmental stage (Steinberg, 2010; Vijayakumar et al., 2019). For most, intense bouts of negative affect, risk taking behavior, and substance use is nothing more than a developmental disturbance without any long-lasting consequences. For others, it is the beginning of an undesirable trajectory and the consequences can be severe. In other words, it is a period in which life trajectories begin to diversify, and opportunities for prevention and intervention are especially pertinent (Cicchetti, 2023).

Developmental psychopathology is the study of complex interactions that influence mental health trajectories. A multidisciplinary approach that incorporates multiple levels of measurement and analysis, the ultimate aim is prevention and intervention (Beauchaine et al., 2018). As such, adolescence and the transition to adulthood are pivotal life stages in the study of developmental psychopathology. The aim of this dissertation was to apply a developmental psychopathology perspective to the study of internalizing pathways to substance use during adolescence; starting with an examination of measurement issues, followed by an in-depth examination of comorbidity in psychopathology using transdiagnostic indicators, and ending with an examination of internalizing symptom profiles and their association with substance use.

Utilizing a dimensional approach to psychopathology, negative affect was the main focus across the three studies. The three studies used original data and national survey data from the Adolescent Brain and Cognitive Development (ABCD; Jernigan et al., 2018) and the Monitoring the Future (MTF; Miech et al., 2022) datasets. The former is the largest longitudinal dataset incorporating neurological, genetic, hormonal and self-report data. Data collection is ongoing and over 11,000 participants will be followed for 10 years, starting at ages 9-10 in 2018. The latter dataset collects a nationally representative sample of 8th, 10th, and 12th grade students in the United States every year. Data have been collected for decades with a focus on tracking trends in substance use and attitudes and behaviors in U.S. adolescents.

In the first study, the measurement and structure of the negative affect construct was assessed using original data collected from an online national sample of 18-30 year-olds. In study 2, NA was combined with impulsivity to examine patterns of comorbidity in preadolescents (9-10 years old) in the first waves of ABCD data. Furthermore, resting state neuroimaging data was used to explore neural correlates of impulsivity in the pre-adolescent brain. In study 3, negative affect profiles defined by levels of anger, anxiety, boredom, depressive affect, and anhedonia were used to predict substance use in mid- to late-adolescence (ages 13 to 18) in the MTF dataset. A number of themes were present throughout the studies including a focus on construct validity, the utility of large, national datasets (necessary to model the complex relationships characteristic of psychopathology), and an exploration of gender moderation. The following discussion will summarize and synthesize the findings across all three studies with a focus on the theoretical and practical implications. The unique contributions of the current findings and future directions are also discussed.

Summary of Results

Study 1

An in-depth psychometric analysis of negative affect was conducted in study 1 (Chapter 2), with the following aims: 1) to establish convergent validity across measures of negative affect, with a focus on items used in two prominent national survey datasets 2) to identify measurement bias across demographic groups with a focus on gender 3) to test the convergent and divergent hypotheses regarding the measurement structure of negative affect and 4) to establish concurrent validity across scales using a number of psychopathology related constructs. In regards to the first and second aims, item response theory (IRT) analyses demonstrated that the Monitoring the Future (MTF) and Adolescent Brain and Cognitive Development (ABCD) items performed very well alongside items from longer, more established scales and did not display any significant differential item functioning (DIF). Additionally, convergent validity was established between items unique to each dataset, allowing one to more easily compare findings across studies. The depression construct, however, unexpectedly split into two factors, seemingly measuring depressive affect and anhedonia. Due to the confound of item wording (positive or negative) convergent validity of depression items outside of MTF and ABCD could not be established.

Using exploratory structural equation modeling (ESEM) the NA measurement structure was tested. The results indicated there was no significant benefit to including a global NA factor, thus supporting the divergent hypothesis of NA. However, there were a number of small cross-loadings across NA sub dimensions suggesting a non-negligible degree of overlap and emphasizing the importance of using ESEM to model NA. In the final structural model, the majority of predicted associations were found, thus providing further evidence for construct

validity. Finally, the differing patterns of association displayed by individual NA constructs once again lends support to the divergent hypothesis of NA.

Study 2

In Chapter 3, NA was combined with impulsivity to predict patterns of comorbidity in a sample of pre-adolescents from the ABCD dataset. Compared to those with no mental health condition (MHC) high levels of anxiety and anger predicted internalizing (IO)and externalizing only (EO), respectively. Heterotypic comorbidity (i.e. having a diagnosis from both the internalizing and externalizing domains of psychopathology) was predicted by higher levels of both anxiety and anger when compared to those with no MHC and those in the IO and EO conditions. Lack of perseverance was the only impulsivity construct to consistently predict membership in one of the three mental health diagnosis categories when compared to the no MHC condition. Among the three mental health diagnosis categories, higher levels of lack of premeditation predicted EO and heterotypic comorbidity. The models included both teacher report forms (TRF) and youth self-report forms (YSR). The measures performed similarly in the models with a few inconsistencies. Broadly, the findings are consistent with previous literature suggesting that internalizing states are more accurately captured by self-report while externalizing behavior can be more easily reported by teachers.

The second set of analyses used brain base set modeling (BBS) to examine neural correlates of impulsivity. By identifying correlates in a pre-adolescent sample, just prior to the average age of substance use initiation (Miech et al., 2022), the aim of the analyses were to set the stage for future studies. Specifically, if neural correlates could be identified in pre-adolescence, future studies might build upon the findings to examine causal relationships between substance use (prior to initiation) and transdiagnostic indicators. The findings indicated

that impulsivity has weak, but widespread associations with neural functioning making it impossible to identify specific neural networks of interest. This suggests that impulsivity may not yet be visible in the brain during pre-adolescence. Alternatively, it may suggest that resting state fMRI data may not be the best way to examine impulsivity in the brain. Instead, task-related fMRI data, or a combination of the two, may prove to be more fruitful (Chen et al., 2022).

Study 3

Chapter 4 used MTF data to create negative affect profiles in a sample of 8th, 10th, and 12th graders. Levels of negative affect (anxiety, depression, boredom, and anger) and low positive affect (anhedonia) resulted in a 5-profile solution that was able to be replicated in an independent sample. Of these profiles, 2 differed in shape while 3 differed in level (Morin & Marsh, 2015). Profiles significantly differed on a number of covariates (e.g., school misbehavior, academic achievement, sensation seeking, parental monitoring, and social interaction). Those in the low NA group reported the lowest levels of substance use while those in the high NA group reported the highest levels of substance use. Gender moderation analyses revealed that despite having similar profiles emerge, males and females differed, in almost all profiles, on levels of anxiety.

Synthesis of Results

Measuring Negative Affect

One overarching goal of the three studies was to address measurement issues involving negative affect and gain a better understanding of the subdimensions of NA. Together, the findings across studies suggest that more work is needed regarding 1) the psychometric properties and convergent validity of NA scales, 2) the structure of NA, and 3) conceptual definitions of affective constructs, especially regarding anhedonia and depressive affect.

Although the current findings (Chapter 2) were largely successful in establishing validity, a number of items did not function as expected, emphasizing the need for a renewed and continued interest in psychometrics in the social sciences.

The lack of convergent validity found for the depression items in study 1 was particularly concerning. Relatedly, in study 2, the depression items did not perform as well as the other negative affect measures. Given that research on depression has been around for decades (Richards, 2011), one might expect the field of psychology to have a better grasp on the measurement of depression. The findings here suggest, however, that this is not the case. This reveals a particularly large and worrisome oversight in measurement validity that needs to be addressed.

The Positive and Negative Affect Schedule (PANAS; Watson & Tellegen, 1985) was an especially problematic measure that should be used with caution in the future. Despite capturing a broad array of negative emotions, PANAS items did not converge with other measures of the same affective state. It may be that, despite modifying the PANAS items to capture trait levels of NA in the current survey, the items only function well when used to capture a global NA trait, or state levels of NA, as originally intended (Watson & Tellegen, 1985). Regardless, the findings show that the PANAS items, despite being widely used and having high face validity, are not suitable for measuring individual facets of NA.

Anhedonia

A larger issue arose with the measurement model of depressive affect. The items split into two factors representing depression and anhedonia. While the MTF and ABCD depression items displayed high convergent validity, the HADS depression items did not load onto the same factor. As such, only the anhedonia items from the HADS scale were used in the end, and the

validity of the depression items was not able to be established as originally intended. Furthermore, the emergence of an anhedonia factor was completely confounded by item wording; depression items were all negatively worded and anhedonia items were all positively worded.

Despite the suggestion that the inclusion of mixed valence items reduces acquiescence in survey data (Chyung et al., 2018), the findings of the current studies demonstrate just how detrimental their inclusion can be. Other studies have shown, for example, that negatively worded items greatly reduce a scales reliability, validity, and cause the emergence of spurious factors (Zeng et al., 2020). In other words, differences in wording introduces multidimensionality into a measure that is very difficult, or even impossible, to disentangle. As such, the current findings regarding depressive affect and anhedonia need to be interpreted with caution.

Attempts were made to further examine and validate the MTF anhedonia items, specifically, as they were used in multiple studies (Chapters 2 and 4). However, the issue of item wording remained, again limiting confidence in the conclusions. Ultimately, the measure of anhedonia present on MTF is most likely a measure of (low) positive affect, which may or may not be synonymous with anhedonia. In fact, neurological studies suggest that anhedonia is not low positive affect, per se, but instead involves specific deficits in dopamine functioning in the reward and motivation systems of the brain (Zisner & Beauchaine, 2016). That being said, studies use varying definitions of anhedonia ranging from complete emotional numbness, to lack of positive affect, to loss of interest or motivation, to the inability to experience pleasure (De Fruyt et al., 2020; Shankman et al., 2014). This lack of consensus in the literature regarding the definition of anhedonia is problematic and requires immediate attention. Moving forward, additional research is needed to 1) come to a consensus on the definition of anhedonia and 2) to

overcome issues of item wording so that anhedonia's validity as a separate construct can be confirmed.

Convergent or Divergent Structure of Negative Affect

Together, the findings can be interpreted in multiple ways regarding the convergent and divergent hypotheses of NA. In support of the latter, the unique pattern of associations found in Chapter 2 structural models highlight how NA facets are differentially related to other psychopathology constructs. Likewise, in Chapter 3, anxiety and anger levels were key in differentiating group membership across comorbidity types, while depressive affect was not particularly useful. This suggests that NA facets provide unique and potentially valuable information for understanding psychopathology and related behavior. In support of the convergent hypothesis, however, the LPA models in Chapter 4 only differed qualitatively in regards to levels of anhedonia (or low positive affect). Looking only at anger, anxiety, boredom and, depression, profiles differed only by level (high, moderate, or low) suggesting that similar levels of each exist within an individual at a given time (as is suggested by the convergent hypothesis; Katon & Roy-Byrne, 1991; Watson & Tellegen, 1985).

Despite some ambiguity in the current findings, the fact that individual facets of NA have the potential to provided unique information makes it is impossible to disregard the divergent hypothesis. In fact, subfacets of NA may be particularly useful, even essential, when trying to understand more nuanced and complex phenomenon, such as the internalizing pathway to substance use. Ultimately, one's experience of and response to emotional states is the result of a myriad of interactions between one's biology and their environment. As just one example, neurotransmitter levels in brain systems associated with approach and avoidance motivations, are suggested to completely moderate how one responds to the experience of anger or anxiety

(Beauchaine & Zisner, 2017 ; Zisner & Beauchaine, 2016). Thus, when studying affect and its association with behavior, it is important to remember that the measures are capturing not only an emotional state, but they are also reflecting how that emotion interacts with cognitive schemas, emotional regulation strategies, and numerous other biological and environmental systems within and around the individual (Beauchaine, 2015; Beauchaine & Hinshaw, 2020).

Gender Moderation in Psychopathology

In general, psychopathology research is lacking studies examining gender moderation (Hartung & Lefler, 2019). As such, the current studies placed an emphasis on identifying gender biased measures and running models separately across gender. The findings showed that DIF by gender was not present in any of the items tested (Chapter 2). Nor did the comorbidity models tested in Chapter 3 differ significantly by gender. Given that the sample consisted of early-/pre-adolescents, and that puberty is suggested to play a leading role in gender differences, it may be that the sample was too young to display significant differences.

In Chapter 4, gender was a significant predictor of group membership; being female associated with the highest levels of negative affect and being male was associated with falling in the emotionally numb group. The finding regarding females is consistent with previous research (Batz & Tay, 2018; Thomsen et al., 2005), but the latter should be interpreted with caution; it may be that LPA is picking up on careless response sets/styles and not true categorical differences in NA.

Finally, while the male and female data both fit the 5 profile solution best (Chapter 4), the substantive meaning of the categories differed thus halting further analyses. Across all but one category, females reported significantly higher levels of anxiety, thus confounding any additional comparisons. This finding emphasizes the already well established finding that anxiety levels are

higher in females than in males (Bandelow & Michaelis, 2015; Farmer et al., 2013). The current findings show that this is true even for females who are part of a "low negative affect" profile. It is beyond the scope of the current study to determine whether the causes for this are biological or social, though theories and studies exist to support both avenues (Hartung & Lefler, 2019). What is clear, however, is that this finding is not an artifact of measurement bias, as established in Chapter 2.

One important limitation regarding the analysis of gender in the current studies is the reliance on binary categorizations of gender identity. Increasingly, researchers are emphasizing the need to better operationalize gender and move away from the male/female binary (see Lindqvist et al., 2020). While MTF (Chapter 4) includes additional gender options on the follow-up panel surveys, the response option is not yet available in the middle and high school samples. While this binary operationalization of gender across the three studies could have resulted in measurement error (Frohard-Dourlent et al., 2017), it also makes the findings less generalizable. Future studies examining measurement and the experience of NA in those who do not identify as male or female are both important and necessary.

Limitations of Neuroimaging Data

Recently, studies documenting the poor reliability of neuroimaging studies have emerged (Rosenberg & Finn, 2022; Tian & Zalesky, 2021). Small effect sizes (as is often the case with neuroscience research, and as was seen in study 2) have recently been shown to lack an ability to replicate (Tian & Zalesky, 2021). This calls into question the validity of conclusions drawn from studies using brain imaging. That is, if the findings cannot be reliability produced, their usefulness is limited at best. However, as some authors note, increased reliability does not guarantee improved prediction of behavior (Finn & Rosenberg, 2021). This is an issue that the

field of neuroimaging still has to remedy before more solid conclusions can be drawn from studies using neuroimaging data.

Relatedly, lack reliability may simply reflect heterogeneity (Finn & Rosenberg, 2021). Not only does brain activity vary within and between individuals, but intraindividual variability is present both within and between tasks (Waschke et al., 2021). Intraindividual variability in neural activity is suggested to be an underappreciated aspect of brain functioning. In the same way our behaviors adapt to changing demands, likely, so do the brain processes used to meet our needs. While these multiple levels of heterogeneity may help explain low reliability and low effect sizes seen in the field of neuroscience, it also makes the brain an infinitely more difficult frontier to navigate in developmental research. More research is needed before larger strides can be made with neuroimaging data (Rosenberg & Finn, 2022).

Implications for Developmental Psychology

The findings presented here have a number of implications for developmental science. Studies 1 and 2 emphasize the importance of taking a developmental consideration of construct measurement. Very little work has yet been done to establish validity of a given measure across varying ages. When different measures are needed to capture a construct at different ages, it is unclear whether or not these scales have convergent validity. Without establishing lack of invariance by age, longitudinal studies of development are filled with potentially extensive measurement error. While study 1 (Chapter 2) addressed issues of validity, additional studies with younger samples are needed to truly address differential item and test functioning by age.

A comparison of the MTF and validation models in study 3 suggest potential differences in the experience of NA in adolescents and young adults. Additional multigroup comparisons by age and latent transition analyses would be especially useful for examining emotional

development and how one experiences negative affect over time. Like the findings from study 2, future studies can build off of study 3 to address developmental concerns linked to continuity and discontinuity in psychopathology, negative affect, and substance use.

Research on Adolescence

Models reflecting ontogenetic continuity focus on distal effects on outcomes, with a focus on early sensitive periods in development. In this view, adolescence may represent what is known as a developmental disturbance (i.e., experiences at this time do not have long term effects; Schulenberg et al., 2019). On the other hand, models reflecting ontogenetic discontinuity take an interactional/systems perspective wherein proximal effects are the focus and can act to reverse or intensify the impact of distal effects (Lerner et al., 2006). In this view, all periods of development, including adolescence are extremely important in terms of ongoing and long-term effects. Due to the constant interaction between an individual and their environment, one's trajectory can remain on course, or be redirected via what is known as turning points (Schulenberg et al., 2019). In these developmental systems models, adolescence represents a primary period for the emergence of turning points in one's life trajectory, making it an especially important stage of development to study further (Schulenberg & Maslowsky, 2015; Schulenberg et al., 2019).

Both ontogenetic continuity and discontinuity during adolescence are important for understanding human development. Thus, a primary aim of developmental research on adolescence is to determine how environmental influences interact with individual differences to result in negative outcomes, such as substance use. More specifically, the aim is to determine for whom are these outcomes a temporary developmental disturbance, and for whom do they

indicate a life-altering turning-point. Likewise, for those on a negative trajectory, what contexts create an opportunity for a turning point in a positive direction?

The current findings were able to aid in clarifying these questions. Additionally, in the current studies, by using samples that range from pre-/early-adolescents through the transition to young adulthood, the studies aid in determining the developmental timing of when these turning points are most likely to occur. Studies 2 and 3 provided evidence that negative affect levels act as an indicator of psychopathology in pre-adolescence (study 2; Chapter 3), and as a potential indicator of substance use in later adolescence (study 3; Chapter 4). Furthermore, both studies are able to aid in clarifying for *whom* levels of negative affect are likely a developmental disturbance and for whom they indicate a negative trajectory.

In study 2, high levels of anger and anxiety, in combination with high levels of behavioral impulsivity (lack of premeditation and lack of perseverance), were associated with higher levels of disfunction (i.e. the EO and IxE groups). Combined with evidence from previous research in the field, it is likely that future studies will show that these groups are on a negative trajectory; being more likely to engage in higher levels of substance use and have more negative outcomes in the future (Beauchaine & McNulty, 2013; Beauchaine et al., 2017). For these individuals, interventions that act as a positive turning point (e.g., strengthening emotional regulation skills) are important to consider (Beauchaine & Cicchetti, 2019).

In study 3, the negative affect profiles revealed that high levels of substance use (among other undesirable outcomes) were most strongly associated with those in the high NA profile. Those in the NA+PA profile also had high levels of negative affect, and the highest levels of sensation seeking, but they reported significantly less substance use than those in the high NA group. This suggests that anhedonia, or lack of positive affect, may be a key indicator for whom

negative affect is a more serious problem during adolescence (high NA) and for whom high levels of negative affect are of potentially less concern (NA+PA). Relatedly, negative affect levels may be useful for determining for whom substance use during adolescence acts as a negative turning point (i.e., high NA), and for whom it is a developmental disturbance (i.e. low NA). Future longitudinal studies are needed to build off of the current analyses and confirm these hypotheses.

While not the main focus of this dissertation, results also revealed some interesting, developmentally relevant findings related to sensation seeking during adolescence. It is well established in the literature that sensation seeking is associated with higher levels of substance use and risk taking behaviors (Freund et al., 2021; Hittner & Swickert, 2006; LaSpada et al., 2020; Lauriola et al., 2014; Zhang et al., 2019). The findings from study 3, however, suggest that it may not be sensation seeking, but the inability to experience pleasure from stimulating experiences that lead to more problematic outcomes associated with high levels of sensation seeking (i.e., the NA+PA group had the highest levels of sensation seeking, but did not have the highest levels of substance use; unlike the high NA group, they also had low levels of anhedonia). In other words, perhaps anhedonia, or lack of positive affect plays an important role in the high sensation seeking and substance use associations so commonly found in the developmental literature.

In sum, along with evidence from previous studies, findings from the current research aid in clarifying issues related to ontogenetic development, multifinality and equifinality, and identifying those who are most at risk for negative psychopathology and substance use outcomes; all of which are of primary importance for the advancement of developmental theory and research, both during adolescence specifically, and across the lifespan.

Broader Implications & Future Directions

Together, the current studies make a number of unique contributions to the literature including 1) providing an in-depth psychometric analysis of survey items related to transdiagnostic indicators 2) establishing convergent validity across negative affect measures included in the MTF and ABCD datasets 3) exploring the combination of impulsivity and NA in heterotypic comorbidity 4) addressing the convergent and divergent hypothesis of NA and 5) eliminating measurement bias as an explanation for negative affect differences across gender and incorporating gender moderation in all models when possible.

The measurement portion of the studies highlight several ongoing issues in psychological research that require further attention in future research; these include issues of measurement validity, multi-informant measures, mixed item wording, and the need for a consensus on the definition and delineation of constructs. The findings in study 1 contribute to the field by establishing the validity of negative affect measures in two widely used and rich sources of secondary data; MTF and ABCD. By establishing convergent validity with independent measures, more confidence can be had in the measurement abilities of these survey items. This aids in overcoming a main limitation in survey data research; sparse items per construct and lack of validation. Furthermore, the ability to crosswalk between MTF and ABCD measures expands opportunities for future research capitalizing on and combining the strengths of each dataset by using integrative data analysis (IDA). The first step in IDA is to harmonize the measures, which has been done here in study 1. This gives future research a head start for implementing IDA with MTF and ABCD. As these types of analyses maximize the potential of secondary data, similar future studies with additional datasets would be valuable to the field.

The current study adds to the growing movement to move beyond diagnoses and take a dimensional approach to psychopathology. A focus on transdiagnostic indicators in study 2 allowed for greater clarity regarding the underlying traits association within and across dimensions of psychopathology. The findings contribute to the fields understanding of heterotypic comorbidity at the trait level, a phenomenon that is still not well understood. Additionally, the findings from the ABCD data in the current study can be used as a baseline for future longitudinal analyses of developmental psychopathology as participants age. By incorporating longitudinal data, more direct research questions regarding the development of psychopathology, and it's association with adolescence substance use, can be addressed.

While no firm answer was revealed regarding the relative validity of the convergent and divergent hypotheses of NA, the findings indicate that NA is a complex and nuanced construct that requires further examination at both the global and sub-facet level. Together, the evidence from the current studies suggest that individual facets of NA can provide unique and potentially valuable information regarding psychopathology, that examining NA alongside other relevant constructs such as impulsivity may further clarify complex phenomena in psychopathology, and that considering levels of NA alongside levels of positive affect may be a particularly fruitful avenue for future research.

All 3 studies addressed concerns regarding gender bias in psychopathology studies. By incorporating gender moderation in study 3, it was revealed that NA profiles differ meaningfully for young men and women. Importantly, the psychometric analyses incorporated in studies 1 and 3 were able to rule out measurement bias as a source of observed gender differences and gender moderation. For a more complete picture regarding the role of gender, future studies are needed

that take a similar gendered approach to psychopathology. Even more crucially, future studies are needed that incorporate gender in non-binary terms.

Another important avenue for future research is the identification of moderators. Negative affect, and emotional states in general, are complex and difficult to model. Finding the right moderators is essential for clarifying the role of emotions in substance use and other outcomes of interest. In study 3, for example, gender was found to significantly moderate the nature of the profile solution, but additional moderators may be even more relevant for understanding the makeup and influence of negative emotions. For example, would children of alcoholics display the same profile solution? How might other developmentally distal experiences influence the experience of negative emotions in adolescence? Exploring these avenues is an important direction for future developmental research.

Conclusions

The current studies highlight a number of methodological issues that need to continue to be addressed with future research, including fundamental issues related to the measurement of psychological constructs. This is especially important for the study of developmental psychopathology wherein important, complex interactions may be obscured by measurement error. The findings presented here contribute to the psychometric literature by establishing convergent validity across the MTF and ABCD datasets; both of which are rich resources for the study of developmental psychopathology. Findings confirm that negative affect is a multidimensional transdiagnostic indicator that is important to the study of psychopathology. Not only are high levels of negative affect associated with substance use, but subfacets aid in predicting heterotypic comorbidity. In addition to the unique information provided by individual facets of NA, at a broader level, negative affect, more generally, needs to be considered

alongside levels of positive affect to truly understand psychopathology. Likewise, gender remains an important, yet neglected, moderator of psychopathology, with its effects likely varying in significance, and across outcomes, throughout adolescence. Overall, the findings provide support the usefulness of transdiagnostic indicators in the study of psychopathology, as well as the existence of an internalizing pathway to substance use. Together, by providing some clarity regarding construct validity, heterotypic comorbidity and, gender moderation, the findings presented here contribute greatly to the field of developmental psychopathology and may lead to more efficient and tailored efforts to prevent and intervene upon at-risk youth during adolescence.

Table 1. Sample Descriptive Statistics, Chapter 2

	Frequency	(%)
Male	358	47%
Married	249	33%
Education: Associates degree or higher	408	54%
Income: Below National Median	385	51%
Race/Ethnicity		
White	429	57%
Black	189	25%
Hispanic	66	8%
Other	69	9%

Table 2. Planned Missingness Design, Chapter 2

Form	Boredom Items	Impulsivity Items
A	BPS Only	Full scale
B	MSBS Only	Full scale
C	MSBS and BPS	Subscales: positive urgency, negative urgency, sensation seeking

Table 3. List of Survey Constructs and Measures, Chapter 2

Source/Scale	# of Items	Citation
Anger		
Positive and Negative Affect Schedule -Extended Version (PANAS-X)	3	Watson & Tellgen, 1985
Monitoring the Future Survey (MTF)	1	
Adolescent Brain and Cognitive Development Study (ABCD)	3	Barch et al., 2018
Anxiety		
State-Trait Anxiety/Depression Inventory (STADI) - Emotionality Subscale	5	Renner et al., 2018
State-Trait Anxiety/Depression Inventory (STADI) - Worry Subscale	5	Renner et al., 2018
Positive and Negative Affect Schedule -Extended Version (PANAS-X)	5	Watson & Tellgen, 1985
Monitoring the Future Survey (MTF)	2	e.g. Freund & Schulenberg, 2022
Adolescent Brain and Cognitive Development Study (ABCD)	3	Barch et al., 2018
Boredom		
Boredom Proneness Scale (BPS) - Short Form	8	Farmer & Sundberg, 1986
Multidimensional State Boredom Scale (MSBS) - Trait Version, Disengagement Subscale	10	Fahlman et al., 2013
Monitoring the Future Survey (MTF)	2	e.g. Martz et al., 2018
Depression		
Hospital Anxiety & Depression Scale (HADS) - Depression Subscale	7	Snaith & Zigmond, 1986
Positive and Negative Affect Schedule -Extended Version (PANAS-X)	6	Watson & Tellgen, 1985
Monitoring the Future Survey (MTF) - Depression Scale	4	e.g. Maslowsky et al., 2013
Monitoring the Future Survey (MTF) - Self-Derogation Scale	4	e.g. Freund et al., 2021
Adolescent Brain and Cognitive Development Study (ABCD)	1	Barch et al., 2018

Table 3 (Continued). List of Survey Constructs and Measures, Chapter 2

Source/Scale	# of Items	Citation
Impulsivity		
Short UPPS-P	20	Cyders et al., 2014
Behavioral Inhibition		
Behavioral Inhibition/Activation Systems (BISBAS) - Behavioral Inhibition Subscale	7	Carver & White, 1994
Behavioral Activation		
Behavioral Inhibition/Activation Systems (BISBAS) - Drive Subscale	4	Carver & White, 1994
Behavioral Inhibition/Activation Systems (BISBAS) - Fun-seekingSubscale	4	Carver & White, 1994
Positive Affect		
Positive and Negative Affect Schedule -Extended Version (PANAS-X)	8	Watson & Tellgen, 1985
Emotional Regulation		
Difficulties in Emotion Regulation Scale (DERS) - Access to Strategies Subscale	7	Gratz & Romer, 2004
Difficulties in Emotion Regulation Scale (DERS) - Lack of Emotional Awareness Subscale	7	Gratz & Romer, 2004
Anhedonia		
Snaith-Hamilton Pleasure Scale (SHAPS)	9	Snaith et al., 1995
Aggression		
Monitoring the Future Survey (MTF)	2	e.g. Maslowsky et al., 2013
Adolescent Brain and Cognitive Development Study (ABCD)	2	Barch et al., 2018

Table 4. Final CFA Model Fit Statistics, Chapter 2

	χ^2	*df*	AIC	SABIC	CFI	TLI	RMSEA	[90% CI]	SRMR
Anger	22.82	6	13753.99	13851.10	0.98	0.96	0.061	[0.036 - 0.089]	0.022
Anxiety	325.81	103	34031.56	34102.54	0.95	0.94	0.054	[0.047 - 0.060]	0.037
Boredom	383.45	169	30274.97	30363.33	0.94	0.93	0.041	[0.036 - 0.047]	0.046
Depression	134.37	44	27032.67	27099.31	0.96	0.95	0.052	[0.042 - 0.062]	0.034
Anhedonia	61.78	14	14726.82	14757.25	0.96	0.95	0.051	[0.051 - 0.085]	0.039

Note: χ2 = Santorra-Bentler Corrected χ2 difference test, AIC = Aikake Information Criterion, SABIC = sample size adjusted Bayesian Information Criterion, CFI = Comparative Fit Index TLI = Tucker-Lewis Index, RMSEA= Root Mean Square Error of Approximation, SRMR= Standardized Root Mean Squared Residual

Table 5. Final Item List with IRT Parameter Estimates, Chapter 2

Latent Trait	Item Label	*M (SD)*	*a*	b_1	b_2	b_3	b_4	Source	Item Text
Anger	ang1	2.59 (1.60)	0.97	-1.098	-0.08 *ns*	1.08	2.58	PANAS	angry
	ang2	2.79 (1.52)	0.65	-1.812	-0.43	1.10	2.70	PANAS	irritable
	ang3	2.41 (1.63)	0.85	-0.813	0.269	1.35	2.69	PANAS	hostile
	ang4	2.80 (1.70)	1.10	-1.159	-0.16	0.63	1.54	MTF	I have trouble controlling my temper
	ang5	2.91 (1.69)	1.15	-1.182	-0.35	0.47	1.50	ABCD	I have a hot temper
	ang6	2.79 (1.77)	1.36	-0.908	-0.22	0.53	1.48	ABCD	I argue a lot
Anxiety	anx1	3.24 (1.30)	1.01	-1.65	-0.68	0.10 *ns*	1.19	MTF	I am often anxious
	anx2	3.33 (1.23)	1.04	-1.81	-0.85	-0.04 *ns*	1.25	MTF	I worry about how people will react to me
	anx3	3.14 (1.31)	1.11	-1.37	-0.63	0.19	1.29	ABCD	I am too fearful or anxious
	anx4	3.19 (1.26)	1.09	-1.55	-0.73	0.19	1.30	ABCD	I am self-conscious or easily embarrassed
	anx5	3.34 (1.26)	1.35	-1.57	-0.80	0.03 *ns*	1.00	ABCD	I worry a lot
	anx6	3.38 (1.26)	1.18	-1.63	-0.89	-0.07 *ns*	1.04	STADI	I worry about problems which could come up
	anx7	3.39 (1.23)	1.16	-1.74	-0.92	-0.06 *ns*	1.09	STADI	I am afraid of what I will be faced with
	anx8	3.51 (1.27)	1.05	-1.82	-1.01	-0.28	0.91	STADI	I am concerned about things that may happen in my future
	anx9	3.39 (1.25)	1.04	-1.87	-0.87	-0.08 *ns*	1.09	STADI	I imagine the worst
	anx10	3.51 (1.20)	1.22	-1.92	-1.01	-0.18	0.89	STADI	I worry about things going wrong
	anx11	3.14 (1.27)	1.11	-1.55	-0.60	0.24	1.32	STADI	My nerves are often tense
	anx12	3.39 (1.24)	1.30	-1.66	-0.83	-0.10 *ns*	1.04	STADI	I am easily stressed
	anx13	3.26 (1.24)	0.93	-1.77	-0.89	0.09 *ns*	1.41	STADI	I often feel restless
	anx14	3.31 (1.25)	1.28	-1.60	-0.76	0.04 *ns*	1.08	STADI	I get nervous easily
	anx15	3.05 (1.23)	0.75	-1.89	-0.65	0.45	1.86	STADI	In general, I lack calmness

Note: All parameters significant at $p < .01$ unless otherwise denoted by *ns* .

Table 5 (Continued). Final Item List with IRT Parameter Estimates, Chapter 2

Latent Trait	Item Label	*M (SD)*	*a*	b_1	b_2	b_3	b_4	Source	Item Text
Boredom	b1	3.16 (1.26)	1.96	-1.52	-0.60	0.14	1.27	MTF	I am often bored
	b2	3.17 (1.26)	2.00	-1.54	-0.58	0.16	1.25	MTF	I often find I have nothing to do
	b3	2.95 (1.21)	1.80	-1.41	-0.43	0.52	1.74	BPS	I often find myself at "loose ends," not knowing what to do
	b4	3.05 (1.28)	1.88	-1.40	-0.46	0.33	1.45	BPS	I find it hard to entertain myself
	b5	3.30 (1.21)	1.76	-1.75	-0.84	0.01 *ns*	1.38	BPS	Many things I have to do are repetitive and monotonous
	b6	3.11 (1.31)	1.62	-1.51	-0.54	0.32	1.31	BPS	It takes more stimulation to get me going than most people
	b7	3.02 (1.28)	1.73	-1.44	-0.39	0.34	1.55	BPS	I don't feel motivated by most things that I do
	b8	3.02 (1.25)	1.80	-1.62	-0.42	0.44	1.43	BPS	In most situations, it is hard for me to find something to do or see to keep me interested
	b9	3.08 (1.30)	1.92	-1.33	-0.48	0.25	1.35	BPS	Much of the time I just sit around doing nothing
	b10	2.85 (1.32)	1.62	-1.22	-0.23	0.54	1.65	BPS	Unless I am doing something exciting, even dangerous, I feel half-dead and dull

Note: All parameters significant at $p < .01$ unless otherwise denoted by *ns* .

Table 5(Continued). Final Item List with IRT Parameter Estimates, Chapter 2

Latent Trait	Item Label	*M (SD)*	*a*	b_1	b_2	b_3	b_4	Source	Item Text
Boredom	b11	3.06 (1.29)	2.00	-1.37	-0.48	0.27	1.25	MSBS	In general, I feel bored
	b12	3.25 (1.25)	1.84	-1.65	-0.72	0.11 *ns*	1.21	MSBS	I am typically indecisive or unsure of what to do
	b13	3.18 (1.22)	2.00	-1.69	-0.61	0.16	1.29	MSBS	I want to do something fun, but nothing usually appeals to me
	b14	3.34 (1.21)	1.47	-2.01	-0.99	-0.01 *ns*	1.34	MSBS	I often wish I was doing something more exciting
	b15	3.28 (1.21)	1.92	-1.77	-0.77	0.08 *ns*	1.18	MSBS	I often feel like I am wasting time that would be better spent on something else
	b16	3.37 (1.19)	2.14	-1.78	-0.81	0.01 *ns*	1.06	MSBS	I often feel like I'm sitting around waiting for something to happen
	b17	3.28 (1.23)	1.51	-1.80	-0.84	-0.03 *ns*	1.49	MSBS	I often feel like I want something to happen but I'm not sure what
	b18	3.05 (1.24)	1.98	-1.51	-0.50	0.36	1.36	MSBS	I am often stuck in situations that I find irrelevant
	b19	3.28 (1.22)	2.03	-1.58	-0.78	0.07 *ns*	1.18	MSBS	In general, everything seems repetitive and routine to me
	b20	3.09 (1.21)	1.91	-1.64	-0.56	0.38	1.35	MSBS	I seem to be forced to do things that have no value to me

Note: All parameters significant at $p < .01$ unless otherwise denoted by *ns* .

Table 5 (Continued). Final Item List with IRT Parameter Estimates, Chapter 2

Latent Trait	Item Label	*M (SD)*	*a*	b_1	b_2	b_3	b_4	Source	Item Text
Depression	d1	2.85 (1.61)	1.07	-1.29	-0.29	0.60	1.80	MTF	I feel that I can't do anything right
	d2	2.92 (1.71)	1.18	-1.16	-0.43	0.42	1.69	MTF	I feel worthless or inferior
	d3	2.80 (1.70)	1.12	-1.11	-0.24	0.64	1.64	MTF	I feel that my life is not very useful
	d4	3.07 (1.66)	1.34	-1.32	-0.51	0.27	1.32	MTF	The future often seems hopeless
	d5	3.00 (1.72)	1.48	-1.15	-0.43	0.33	1.30	MTF	Life often seems meaningless
	d6	2.93 (1.77)	1.24	-1.07	-0.40	0.43	1.38	ABCD	I am unhappy, sad, or depressed
	d7	2.71 (1.25)	0.56	-1.83	-0.21 *ns*	1.35	2.79	PANAS	sluggish
	d8	2.70 (1.32)	0.91	-1.26	-0.10 *ns*	0.87	2.19	PANAS	sad
	d9	2.72 (1.30)	0.69	-1.41	-0.21 *ns*	0.97	2.45	PANAS	distressed
	d10	2.76 (1.37)	0.84	-1.29	-0.20 *ns*	0.85	2.04	PANAS	lonely
	d11	3.28 (1.18)	0.77	-2.30	-1.00	0.14 *ns*	1.58	HADS	I feel as if I am slowed down
	d12	3.08 (1.23)	0.57	-2.34	-0.89	0.54	2.16	HADS	I have little interest in my appearance
Anhedonia	a1	2.43 (1.39)	1.44	-0.83	0.24	1.06	1.83	MTF	I enjoy life as much as anyone
	a2	2.32 (1.38)	1.30	-0.70	0.38	1.18	1.99	MTF	It feels good to be alive
	a3	2.50 (1.41)	1.03	-1.04	0.22	1.06	2.13	HADS	I still enjoy the things I used to enjoy
	a4	2.22 (1.28)	1.03	-0.67	0.60	1.41	2.40	HADS	I can laugh and see the funny side of things
	a5	2.51 (1.34)	0.94	-1.09	0.32	1.39	2.56	HADS	I feel cheerful
	a6	2.40 (1.20)	0.92	-0.69	0.43	1.31	2.17	HADS	I look forward with enjoyment to things
	a7	2.33 (1.24)	1.02	-1.08	0.13 *ns*	1.14	2.20	HADS	I can enjoy a good book or radio or TV program

Note: All parameters significant at $p < .01$ unless otherwise denoted by *ns* .

Table 6. Standardized Beta Weights from MIMIC Models, Chapter 2

	Latent Mean				
	Anger	Anxiety	Boredom	Depression	Anhedonia
Income					
Age	-0.14				-0.27
Gender					
Male = 1		-0.14			0.11
Education					
2 yr degree or higher = 1		-0.13	-0.11	-0.13	0.10
Race/Ethnicity					
White = 1		0.13			-0.19
Black = 1					
Hispanic = 1					

Note: Only values significant at p <.01 are shown.

Table 7. CFA and ESEM Model Fit and Nested Comparisons, Chapter 2

Model Type	Model #	$\chi 2$	AIC	SABIC	CFI	TLI	RMSEA	[95% CI]	SRMR
CFA Models									
First-Order	1	3106.49	105501.9	105759.8	0.89	0.88	0.040	[.038, .042]	0.059
Bi-Factor	2	2839.60	105266.1	105589.2	0.90	0.88	0.038	[.036, .040]	0.070
Hierarchical	3	3107.66	93586.6	93802.4	0.85	0.84	0.048	[.046, .050]	0.120
ESEM Models									
First-Order	4	1670.31	93785.5	94282.3	0.95	0.94	0.031	[.028, .033]	0.028
Bi-Factor	5	1936.89	104732.9	105348.5	0.95	0.94	0.030	[.027, .032]	0.027
Nested Model Comparisons		$\Delta \chi^2$	*Δ AIC*	*Δ aBIC*	*Δ CFI*	*Δ TLI*	*Δ RMSEA*	*Δ SRMR*	
	1 v 2	-266.89	-235.79	-170.59	0.01	0.00	0.00	0.01	
	1 v 3	1.17	-11915.30	-11957.32	-0.04	-0.04	0.01	0.06	
	1 v 4	-1436.18	-11716.39	-11477.46	0.06	0.06	-0.01	-0.03	
	2 v 4	-1169.29	-769.04	-411.26	0.06	0.06	-0.01	-0.03	
	2 v 5	-902.71	-11480.60	-11306.87	0.05	0.06	-0.01	-0.04	
	4 v 5	266.58	10947.35	11066.20	0.00	0.00	0.00	0.00	

Note: $\chi 2$ = Santorra-Bentler Corrected $\chi 2$ difference test, AIC = Aikake Information Criterion, SABIC = sample size adjusted Bayesian Information Criterion, CFI = Comparative Fit Index TLI = Tucker-Lewis Index, RMSEA= Root Mean Square Error of Approximation, SRMR= Standardized Root Mean Squared Residual, CFA = Confirmatory Factor Analysis, ESEM = Exploratory Structural Equation Modeling.

Table 8. ESEM Final Model Factor Loadings, Chapter 2

	Factor				
Item	Anger	Anxiety	Boredom	Depression	Anhedonia
ang1	**0.44**				0.17
ang4	**0.60**	0.11			-0.12
ang5	**0.71**				
ang6	**0.64**				
anx1		**0.68**			
anx2		**0.64**			
anx3	0.16	**0.65**			0.11
anx4		**0.70**			
anx5		**0.80**			
anx6		**0.73**			
anx7		**0.70**			
anx8		**0.65**			-0.14
anx9	0.14	**0.65**			
anx10		**0.72**			
anx11		**0.62**			
anx12		**0.66**			
anx14		**0.74**			
b1			**0.62**		
b2			**0.68**		0.12
b3			**0.56**		
b4	0.21		**0.63**		
b5			**0.77**		

Note: Only values significant at p <.01 are shown.

Table 7 (Continued). ESEM Final Model Factor Loadings, Chapter 2

	Factor				
Item	Anger	Anxiety	Boredom	Depression	Anhedonia
b6	0.19		**0.54**		
b7			**0.55**		0.13
b8			**0.56**		
b9			**0.63**		
b10			**0.54**		
b11			**0.59**		
b12		0.16	**0.53**		
b13			**0.72**		
b14			**0.69**		-0.13
b15	-0.15		**0.67**		
b16			**0.74**		
b17			**0.61**	-0.15	-0.13
b18			**0.70**		
b19			**0.74**		
b20		-0.12	**0.76**		
d3		0.15		**0.44**	0.11
d4				**0.80**	-0.11
d5		-0.11		**0.92**	
d6		0.13		**0.58**	0.11
a1	-0.14	0.11			**0.72**
a2					**0.66**
a3					**0.70**
a4	0.11		-0.10		**0.65**
a6					**0.65**
a7					**0.66**

Note: Only values significant at p <.01 are shown.

Table 9. Latent Mean Correlations From Final ESEM Model, Chapter 2

	1	2	3	4	5
1. Anger	1				
2. Anxiety	0.27*	1			
3. Boredom	0.44*	0.62*	1		
4. Depression	0.48*	0.50*	0.57*	1	
5. Anhedonia	0.14*	-0.15*	0.01	0.29*	1

* significant at $p < .01$

Table 10. ESEM Structural Model Standardized Beta Coefficients, Chapter 2

	PA	ER-A	ER-S	Agg.	PU	NU	BIS	BAS-D	BAS-F
Anger			-0.52	0.61	0.67	0.67		0.17	
Anxiety	-0.15	0.33	-0.69		0.27	0.60	0.70	0.30	0.26
Boredom		0.19	-0.69	0.22	0.54	0.72	0.55	0.33	0.42
Depression	-0.17		-0.71	0.42	0.54	0.61	0.30	0.18	0.22
Anhedonia	-0.54	-0.65		0.20			-0.33	-0.53	-0.51

Note: Only coefficients that are significant at $p < .01$ are shown. PA = Positive Affect, ER-A = Emotional Regulation – DERS Emotional Awareness Subscale; ER-S = Emotional Regulation – DERS Strategies Subscale; Agg = Agression; PU = UPPS-P Positive Urgency Subscale, NU = UPPS-P Negative Urgency Subscale, BIS = Behavioral Inhibition Subscale; BAS-D = Behavioral Activation- BISBAS Drive Subscale; BAS-F = Behavioral Activation - BISBAS Fun Seeking Subscale.

Table 11. ABCD Sample Demographic Statistics, Chapter 3

		Sub-Sample 1 *N* = 3,500	Sub-Sample 2 *N* = 6439
Male		51%	51%
Race/Ethnicity			
	Black	10%	12%
	White	62%	58%
	Hispanic	16%	19%
	Other	2%	11%
Parental Education			
	Bachelor's Degree +	67%	64%
Parental Income			
	< 50K	22%	24%
	50K - 100K	30%	28%
	> 100K	48%	41%

Note: Sample demographic statistics for the multinomial logistic regression (sub-sample 1) and the BBS (sub-sample 2) analyses

Table 12. Correlations Between Negative Affect and Impulsivity Measures, Chapter 3

		1	2	3	4	5	6	7	8	9	10
1	Negative Urgency	1									
2	Positive Urgency	0.49	1								
3	Lack of Premeditation	0.16	0.21	1							
4	Lack of Perseverance	0.13	0.17	0.45	1						
5	TRF - Depression	0.09	0.08	0.09	0.15	1					
6	TRF - Anxiety	0.05	0.05	0.02 *ns*	0.12	0.62	1				
7	TRF - Anger	0.12	0.12	0.14	0.11	0.46	0.27	1			
8	YSR - Depression	0.16	0.17	0.06	0.12	0.21	0.16	0.16	1		
9	YSR - Anxiety	0.19	0.18	0.04	0.11	0.18	0.17	0.12	0.44	1	
10	YSR - Anger	0.26	0.23	0.20	0.17	0.15	0.07	0.25	0.33	0.40	1

Note: All correlations significant at $p < .001$ unless otherwise indicated by *ns* . TRF = teacher report form; YSR = youth self-report.

Table 13. Multinomial Logistic Regression Adjusted Odds Ratios, Chapter 3

Reference Group	No MHC					
Comparison Group	*Internalizing (IO)*		*Externalizing (EO)*		*Heterotypic (IxE)*	
	AOR	95% CI	AOR	95% CI	AOR	95% CI
Demographics						
Male (= 1)	0.83	[0.69, 1.00]	**1.47**	**[1.17, 1.85]**	**1.29**	**[1.05, 1.57]**
Black (= 1)	0.91	[0.64, 1.29]	0.94	[0.62, 1.43]	**0.63**	**[0.43, 0.92]**
Hisp (=1)	**0.70**	**[0.53, 0.93]**	0.84	[0.60, 1.17]	0.74	[0.56, 1.00]
Other (= 1)	**0.50**	**[0.25, 0.98]**	0.92	[0.45, 1.88]	0.48	[0.22, 1.05]
Income	0.87	[0.75, 1.01]	1.01	[0.84, 1.21]	**0.70**	**[0.60, 0.82]**
Parental Education	1.12	[1.00, 1.25]	1.03	[0.89, 1.18]	**1.26**	**[1.11, 1.42]**
Impulsivity						
Negative Urgency	**0.83**	**[0.70, 0.98]**	0.96	[0.78, 1.17]	1.10	[0.92, 1.31]
Positive Urgency	1.00	[0.85, 1.17]	**1.20**	**[1.01, 1.45]**	1.07	[0.91, 1.26]
Premeditation	0.87	[0.71, 1.05]	1.19	[0.95, 1.48]	1.18	[0.97, 1.44]
Perseverance	**1.34**	**[1.10, 1.64]**	**1.31**	**[1.04, 1.65]**	**1.36**	**[1.11, 1.67]**
Negative Affect (YSR)						
Depressive Affect	0.76	[0.54, 1.07]	1.13	[0.79, 1.62]	1.24	[0.92, 1.68]
Anxiety	**1.30**	**[1.02, 1.64]**	0.94	[0.70, 1.25]	**1.33**	**[1.05, 1.70]**
Anger	1.12	[0.91, 1.38]	**1.46**	**[1.15, 1.85]**	**1.35**	**[1.10, 1.67]**
Negative Affect (TRF)						
Depressive Affect	0.89	[0.64, 1.25]	**1.57**	**[1.09, 2.25]**	1.22	[0.89, 1.66]
Anxiety	**1.52**	**[1.19, 1.94]**	1.04	[0.77, 1.42]	**1.73**	**[1.34, 2.22]**
Anger	0.98	[0.76, 1.27]	**1.62**	**[1.27, 2.08]**	**2.09**	**[1.69, 2.59]**

Note: Multinomial logistic regression odds ratios with confidence intervals in brackets. Significant odds ratios are in bold. No MHC = no mental health condition; AOR = adjusted odds ratio; YSR = youth self-report form; TRF = teacher report form.

*Table 13 (Continued)*Multinomial Logistic Regression Adjusted Odds Ratios, Chapter 3

Reference Group	Heterotypic (IxE)				Internalizing (IO)	
Comparison Group	*Internalizing (IO)*		*Externalizing (EO)*		*Externalizing (EO)*	
	AOR	95% CI	AOR	95% CI	AOR	95% CI
Demographics						
Male (= 1)	**0.65**	**[0.52, 0.81]**	1.14	[0.88,1.48]	**1.76**	**[1.36, 2.27]**
Black (= 1)	1.45	[0.94, 2.23]	1.51	[0.95, 2.40]	1.04	[0.65, 1.66]
Hisp (=1)	0.94	[0.67,1.33]	1.13	[0.78,1.64]	1.20	[0.82, 1.76]
Other (= 1)	1.03	[0.41, 2.63]	1.91	[0.74, 4.93]	1.85	[0.76, 4.47]
Income	**1.23**	**[1.03, 1.47]**	**1.43**	**[1.17, 1.75]**	1.16	[0.95, 1.42]
Parental Education	0.89	[0.77, 1.02]	**0.81**	**[0.70, 0.95]**	0.92	[0.79, 1.07]
Impulsivity						
Negative Urgency	**0.75**	**[0.62, 0.92]**	0.88	[0.70, 1.09]	1.16	[0.93, 1.46]
Positive Urgency	0.93	[0.77, 1.12]	1.13	[0.92, 1.37]	1.21	[0.98, 1.48]
Premeditation	**0.73**	**[0.58, 0.92]**	1.01	[0.79, 1.27]	**1.37**	**[1.07, 1.76]**
Perseverance	0.99	[0.79, 1.24]	0.96	[0.75, 1.24]	0.97	[0.75, 1.26]
Negative Affect (YSR)						
Depressive Affect	**0.61**	**[0.42, 0.88]**	0.91	[0.63, 1.31]	1.50	[0.99, 2.27]
Anxiety	0.97	[0.74, 1.28]	**0.70**	**[0.52, 0.96]**	**0.72**	**[0.53, 0.99]**
Anger	0.83	[0.65, 1.05]	1.08	[0.84, 1.39]	1.31	[1.00, 1.70]
Negative Affect (TRF)						
Depressive Affect	0.73	[0.51, 1.05]	1.29	[0.89, 1.85]	**1.76**	**[1.17, 2.64]**
Anxiety	0.88	[0.66, 1.16]	**0.60**	**[0.44, 0.83]**	**0.69**	**[0.49, 0.96]**
Anger	**0.50**	**[0.36, 0.61]**	**0.78**	**[0.61, 0.99]**	**1.65**	**[1.24, 2.21]**

Note: Multinomial logistic regression odds ratios with confidence intervals in brackets. Significant adjusted odds ratios are in bold. AOR = adjusted odds ratio; YSR = youth self-report form; TRF = teacher report form.

Table 14. Impulsivity and Negative Affect Descriptive Statistics by Mental Health Diagnosis, Chapter 3

	Full Sample	No MHC	Internalizing	Externalizing	Heterotypic
	N = 11,850	*n* = 2078	*n* = 1004	*n* = 601	*n* = 921
	M (SD)	M (SD)	M (SD)	M SD	M (SD)
Impulsivity					
Negative Urgency	2.12 (0.66)	2.09 (0.64)	2.05 (0.65)	2.22 (0.64)	2.28 (0.69)
Positive Urgency	2.00 (0.74)	1.94 (0.71)	1.92 (0.72)	2.10 (0.76)	2.12 (0.77)
Lack of Premeditation	1.94 (0.59)	1.90 (0.55)	1.87 (0.54)	2.02 (0.59)	2.06 (0.66)
Lack of Perseverance	1.76 (0.56)	1.68 (0.51)	1.72 (0.54)	1.81 (0.54)	1.88 (0.60)
Negative Affect (YSR)					
Depressive Affect	1.16 (0.35)	1.12 (0.31)	1.13 (0.31)	1.19 (0.37)	1.25 (0.42)
Anxiety	1.41 (0.46)	1.36 (0.43)	1.42 (0.46)	1.42 (0.46)	1.53 (0.51)
Anger	1.52 (0.54)	1.45 (0.50)	1.47 (0.50)	1.63 (0.58)	1.67 (0.58)
Negative Affect (TRF)					
Depressive Affect	1.20 (0.42)	1.13 (0.34)	1.16 (0.36)	1.25 (0.43)	1.38 (0.55)
Anxiety	1.39 (0.48)	1.32 (0.42)	1.39 (0.47)	1.39 (0.47)	1.57 (0.57)
Anger	1.27 (0.51)	1.18 (0.42)	1.18 (0.42)	1.37 (0.56)	1.50 (0.66)

Note: Impulsivty and negative affect descriptive statistics for the multinomial logistic regression analyses; No MHC = No mental health condition.

Table 15. Descriptive Statistics for the Full Sample and Individual Latent Profiles, Chapter 4

	Full Sample (N = 49,346) M (SD) / %	Low NA (N = 28,616) M (SD) / %	Moderate NA (N = 12,060) M (SD) / %	High NA (N = 3,645) M (SD) / %	NA+PA (N = 3,382) M (SD) / %	Numb (N = 1,643) M (SD) / %
Age	15.88 (1.63)	15.87 (1.64)	15.99 (1.62)	15.68 (1.51)	15.82 (1.62)	15.91 (1.75)
Grade Level						
8	37%	38%	34%	39%	39%	44%
10	39%	37%	40%	43%	41%	34%
12	24%	25%	27%	18%	20%	22%
Gender						
Female	52%	49%	56%	68%	50%	35%
Male	48%	51%	44%	32%	50%	65%
Race/Ethnicity						
Black	11%	11%	9%	8%	16%	25%
White	47%	51%	46%	47%	33%	28%
Hisp	21%	20%	22%	18%	27%	25%
Other	19%	16%	20%	25%	22%	21%
Parental Education						
Less than HS degree	10%	8%	11%	12%	14%	21%
HS Degree	17%	15%	19%	18%	21%	23%
Some college	16%	16%	18%	19%	15%	14%
College Degree	33%	35%	31%	31%	28%	24%
Graduate School	23%	25%	21%	21%	21%	19%
Grade in School						
D (69 or below)	2%	1%	3%	5%	3%	8%
C (70-79)	16%	12%	20%	23%	23%	24%
B (80-89)	42%	41%	43%	40%	45%	38%
A (90-100)	40%	46%	34%	32%	29%	31%
School Behavior						
Cut Class Last 2 weeks	1.36 (1.00)	1.28 (0.86)	1.43 (1.09)	1.55 (1.57)	1.50 (1.23)	1.58 (1.39)
Heldback	1.11 (0.34)	1.08 (0.30)	1.12 (0.36)	1.10 (0.34)	1.17 (0.43)	1.29 (0.57)
Suspended	1.31 (0.63)	1.25 (0.57)	1.34 (0.66)	1.38 (0.69)	1.44 (0.72)	1.62 (0.81)
Social Interaction						
Times Out Per Week	2.58 (1.48)	2.71 (1.46)	2.39 (1.44)	2.16 (1.44)	2.77 (1.60)	2.43 (1.60)
Community Service	2.19 (1.07)	2.27 (1.05)	2.09 (1.05)	1.99 (1.06)	2.10 (1.15)	2.09 (1.30)
Sports Participation	4.09 (1.63)	4.35 (1.51)	3.74 (1.69)	3.35 (1.76)	3.98 (1.70)	4.07 (1.75)
Solitary Leisure	3.70 (1.27)	3.67 (1.22)	3.78 (1.27)	3.96 (1.29)	3.69 (1.39)	3.18 (1.68)
Parental Involvement	2.64 (0.73)	2.77 (0.70)	2.50 (0.71)	2.32 (0.72)	2.59 (0.76)	2.24 (0.92)
Sensation Seeking	3.18 (1.13)	3.21 (1.10)	3.19 (0.95)	3.29 (1.18)	3.80 (1.00)	1.28 (0.69)
Substance Use						
30-Day Marijuana Use	1.38 (1.17)	1.29 (1.02)	1.48 (1.30)	1.58 (1.40)	1.57 (1.46)	1.46 (1.32)
Past 2-week Binge Drinking	9%	7%	10%	12%	11%	9%
Past 12-month Drug Use	8%	6%	11%	19%	11%	9%

Note: Descriptive statistics for the MTF sample. Includes all variables used in the multinomial regression analysis. For race, the category of "other" includes those who identify as Asian, Native American, Hawaiian or Pacific Islander, or biracial.

Table 16. Factor Means and Correlations, Chapter 4

	Indicator	M (SD)	1	2	3	4	5
1	Anhedonia	2.11 (1.15)	-				
2	Depressive Affect	2.30 (1.23)	0.49	-			
3	Anxiety	3.12 (1.33)	0.24	0.45	-		
4	Boredom	3.32 (1.33)	0.17	0.41	0.43	-	
5	Anger	2.63 (1.39)	0.14	0.34	0.33	0.31	-

Table 17. LPA Model Fit Statistics, Chapter 4

	k	p	LL	SABIC	AIC	CAIC	LMR LRT	Entropy
MTF Adolescent Sample								
(N = 49,346)	1	20	-321149.39	642451.42	642338.79	642412.68	-	-
	2	26	-313836.46	627871.34	627724.92	627820.97	14403.79	0.98
	3	32	-308087.39	616418.99	616238.78	616357.01	11323.54	0.89
	4	38	-304375.97	609041.94	608827.94	608968.33	7310.14	0.90
	5	**44**	**-301188.68**	**602713.14**	**602465.35**	**602627.91**	**6277.79**	**0.87**
	6	50	-299387.34	599156.26	598874.68	599059.41	2005.81	0.86
	7	56	-296993.21	594413.79	594098.42	594305.31	1447.87	0.83
	8	62	-294392.13	589257.42	588908.26	589137.32	1499.79	0.84
Young Adult Sample								
(N = 753)	1	20	-5760.73	11590.44	11561.47	11599.00	-	-
	2	26	-5714.66	11518.99	11481.33	11530.12	89.88	0.71
	3	32	-5678.56	11467.47	11421.11	11481.17	70.44	0.69
	4	38	-5636.02	11403.09	11348.04	11419.36	82.98	0.75
	5	**44**	**-5594.89**	**11341.53**	**11277.79**	**11360.37**	**80.23**	**0.80**
	6	50	-5580.54	11333.52	11261.09	11354.93	27.99 *ns*	0.78
	7	56	-5565.95	11325.03	11243.91	11349.01	28.47 *ns*	0.76
	8	62	-5555.048	11323.913	11234.096	11350.4573	21.28 *ns*	0.78

Note: Fit statistics for the1 through 8-profile models. LL = Log-likelihood; p = number of parameters; k = number of profiles; SABIC = sample size adjusted Bayesian Information Criterion; AIC = Aikake's Information Criterion; CAIC = Consistent AIC; LMR LRT = Vuong-Lo-Mendell-Rubin likelihood ratio test; All LMR LRT values significant at p < .001 unless indicated by *ns* . Final model statistics are shown in bold.

Table 18. LPA Final Model Unstandardized Profile Means, Chapter 4

	Profile 1 *Low NA*	Profile 2 *Moderate NA*	Profile 3 *High NA*	Profile 4 *NA+P*	Profile 5 *Numb*	SD	Univariate Entropy
MTF Adolescent Sample (N = 49,346)							
Proportion	58%	24%	7%	7%	3%		
Sample Size	n = 28,616	n = 12,060	n = 3,645	n = 3,382	n = 1,643		
Anhedonia	1.34	2.84	4.35	1.46	4.88	0.45	0.73
Depressive Affect	1.69	3.07	4.15	3.89	1.18	0.75	0.57
Anxiety	2.78	3.60	4.34	3.77	1.21	1.22	0.32
Boredom	3.06	3.72	4.27	4.03	1.43	1.23	0.29
Anger	2.39	2.96	3.42	3.59	1.14	1.34	0.28
Young Adult Sample (N = 753)							
Proportion	*25%*	*38%*	*6%*	*25%*	*6%*		
Sample Size	n = 190	n = 282	n = 44	n = 192	n = 45		
Anhedonia	1.51	2.87	4.16	1.65	4.15	0.56	0.49
Depressive Affect	1.67	3.17	4.36	4.15	1.86	0.63	0.49
Anxiety	3.11	3.16	4.09	3.65	2.38	1.02	0.16
Boredom	2.71	3.09	3.88	3.64	2.61	1.20	0.15
Anger	2.18	2.92	2.73	3.36	2.43	1.23	0.16

Note: Estimated indicator means and standard deviations for each profile. Standard deviations are constrained to be equal across profiles. NA = negative affect; NA+PA = high negative and positive affect.

Table 19. LPA Final Model Classification Statistics, Chapter 4

		AvePP					OCC
	Profile	Low NA	Mod NA	High NA	NA+PA	Numb	
MTF Adolescent Sample							
(N = 49,346)	Low NA	**0.93**	0.04	0.00	0.03	0.00	173.81
	Mod NA	0.04	**0.91**	0.03	0.01	0.00	139.40
	High NA	0.00	0.09	**0.91**	0.00	0.01	128.03
	NA+PA	0.11	0.06	0.00	**0.82**	0.00	60.93
	Numb	0.00	0.01	0.02	0.00	**0.97**	461.13
Young Adult Sample							
(N = 753)	Low NA	**0.92**	0.05	0.00	0.02	0.01	36.47
	Mod NA	0.04	**0.83**	0.03	0.07	0.03	8.14
	High NA	0.00	0.12	**0.86**	0.00	0.02	17.34
	NA+PA	0.02	0.09	0.01	**0.88**	0.00	117.10
	Numb	0.01	0.12	0.00	0.00	**0.87**	104.85

Note. AvePP = Average posterior class probability; OCC = odds of correct classification. AvePP values for each class shown in bold.

Table 20. Adjusted Odds Ratios From LPA Covariate Analysis, Chapter 4

Reference Profile	Low NA							
Comparison Profile	*Moderate NA*		*High NA*		*NA+PA*		*Numb*	
	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI
Demographics								
Age	0.90	[0.80, 1.00]	0.74 **	[0.60, 0.92]	1.06	[0.84, 1.33]	0.85	[0.49, 1.47]
Grade Level	1.12	[1.00, 1.26]	1.14	[0.91, 1.42]	0.87	[0.69, 1.09]	1.06	[0.62, 1.83]
Male	0.65 ***	[0.59, 0.72]	0.41 ***	[0.35, 0.49]	0.81 *	[0.66, 0.99]	1.90 **	[1.28, 2.81]
Black	0.77 **	[0.64, 0.93]	0.57 **	[0.40, 0.80]	2.82 ***	[2.02, 3.95]	1.82 *	[1.05, 3.17]
Hispanic	0.99	[0.84, 1.17]	0.76 *	[0.58, 0.99]	2.10 ***	[1.61, 2.73]	1.60	[0.83, 3.09]
Other	1.19 *	[1.04, 1.38]	1.43 **	[1.16, 1.77]	2.29 ***	[1.76, 2.99]	1.71 *	[1.08, 2.71]
Parental Education	0.99	[0.94, 1.03]	1.02	[0.95, 1.09]	0.98	[0.89, 1.07]	0.91	[0.75, 1.09]
School								
Grade in School	0.84 ***	[0.82, 0.87]	0.81 ***	[0.78, 0.84]	0.85 ***	[0.81, 0.89]	0.80 ***	[0.73, 0.87]
Cut Class Last 2 weeks	1.05	[0.99, 1.12]	1.08	[0.99, 1.17]	1.08	[0.97, 1.21]	1.31	[0.91, 1.88]
Heldback	1.14	[0.93, 1.39]	1.06	[0.75, 1.50]	1.63 **	[1.21, 2.21]	1.15	[0.68, 1.95]
Suspended	1.23 ***	[1.11, 1.37]	1.20 *	[1.04, 1.40]	1.15	[0.95, 1.38]	2.22 ***	[1.60, 3.08]
Social Interaction								
Times Out Per Week	0.84 ***	[0.81, 0.88]	0.73 ***	[0.68, 0.78]	0.95	[0.89, 1.02]	1.06	[0.94, 1.20]
Community Service	1.01	[0.96, 1.06]	1.00	[0.92, 1.08]	1.00	[0.91, 1.10]	1.00	[0.83, 1.21]
Sports Participation	0.85 ***	[0.82, 0.87]	0.75 ***	[0.72, 0.79]	0.88 ***	[0.83, 0.94]	1.01	[0.88, 1.15]
Solitary Leisure	1.11 ***	[1.07, 1.16]	1.31 ***	[1.19, 1.44]	1.07	[0.98, 1.18]	0.83 **	[0.73, 0.94]
Parental Involvement	0.63 ***	[0.59, 0.68]	0.42 ***	[0.38, 0.47]	0.77 **	[0.66, 0.90]	0.40 ***	[0.32, 0.52]
Sensation Seeking	0.92 **	[0.87, 0.97]	1.03	[0.95, 1.13]	2.27 ***	[2.00, 2.58]	0.01 ***	[0.00, 0.02]
Substance Use								
2-week Binge Drinking	1.17	[0.97, 1.43]	1.54 **	[1.17, 2.03]	0.97	[0.65, 1.43]	2.70	[0.97, 7.56]
30-Day Marijuana Use	1.07 *	[1.01, 1.14]	1.13 **	[1.04, 1.22]	1.03	[0.95, 1.12]	1.38 **	[1.11, 1.71]
Past 12-month Drug Use	1.64 ***	[1.34, 2.01]	3.00 ***	[2.32, 3.86]	1.26	[0.89, 1.76]	2.66 **	[1.34, 5.29]

Note: Adjusted odds ratios from the final 5-profile model using low NA as the reference group. AOR = adjusted odds ratio; 95%CI = 95% confidence interval

*p < .05

**p < .01

***p < .001

Table 20 (Continued). Adjusted Odds Ratios From LPA Covariate Analysis, Chapter 4

Reference Profile	High NA					
Comparison Profile	*Mod NA*		*NA+P*		*Numb*	
	AOR	95% CI	AOR	95% CI	AOR	95% CI
Demographics						
Age	1.21	[0.97, 1.51]	1.43 **	[1.09, 1.88]	1.15	[0.63, 2.09]
Grade Level	0.99	[0.78, 1.25]	0.76	[0.58, 1.01]	0.94	[0.52, 1.70]
Male	1.58 ***	[1.32, 1.89]	1.95 ***	[1.53, 2.49]	4.58 ***	[2.99, 7.02]
Black	1.36	[0.96, 1.92]	4.98 ***	[3.19, 7.77]	3.21 ***	[1.76, 5.83]
Hispanic	1.31	[0.98, 1.73]	2.76 ***	[1.92, 3.98]	2.11 *	[1.04, 4.27]
Other	0.83	[0.66, 1.04]	1.60 **	[1.18, 2.16]	1.19	[0.74, 1.92]
Parental Education	0.97	[0.90, 1.04]	0.96	[0.87, 1.06]	0.89	[0.73, 1.08]
School						
Grade in School	1.04	[0.99, 1.08]	1.05	[0.99, 1.11]	0.99	[0.90, 1.08]
Cut Class Last 2 weeks	0.98	[0.90, 1.06]	1.00	[0.90, 1.12]	1.21	[0.82, 1.78]
Heldback	1.07	[0.78, 1.48]	1.54 *	[1.07, 2.22]	1.09	[0.58, 2.04]
Suspended	1.02	[0.88, 1.19]	0.95	[0.77, 1.17]	1.84 **	[1.30, 2.62]
Social Interaction						
Times Out Per Week	1.16 ***	[1.08, 1.25]	1.31 ***	[1.20, 1.43]	1.46 ***	[1.27, 1.69]
Community Service	1.01	[0.92, 1.11]	1.00	[0.89, 1.13]	1.00	[0.82, 1.24]
Sports Participation	1.13 ***	[1.07, 1.19]	1.17 ***	[1.09, 1.25]	1.34 ***	[1.16, 1.54]
Solitary Leisure	0.85 **	[0.77, 0.94]	0.82 **	[0.72, 0.93]	0.63 ***	[0.53, 0.75]
Parental Involvement	1.49 ***	[1.32, 1.68]	1.82 ***	[1.53, 2.16]	0.95	[0.73, 1.24]
Sensation Seeking	0.89 *	[0.81, 0.98]	2.20 ***	[1.89, 2.56]	0.01 ***	[0.00, 0.02]
Substance Use						
2-week Binge Drinking	0.76	[0.57, 1.02]	0.63 *	[0.41, 0.96]	1.75	[0.61, 4.99]
30-Day Marijuana Use	0.95	[0.89, 1.02]	0.91	[0.83, 1.01]	1.22	[0.98, 1.52]
Past 12-month Drug Use	0.55 ***	[0.42, 0.71]	0.42 ***	[0.29, 0.60]	0.89	[0.43, 1.84]

Note: Adjusted odds ratios from the final 5-profile model using high NA as the reference group. AOR = adjusted odds ratio; 95%CI = 95% confidence interval

*p < .05

**p < .01

***p < .001

Table 20 (Continued). Adjusted Odds Ratios From LPA Covariate Analysis, Chapter 4

Reference Profile	NA+P				Mod NA	
Comparison Profile	*Mod NA*		*Numb*		*Numb*	
	AOR	95% CI	AOR	95% CI	AOR	95% CI
Demographics						
Age	0.84	[0.67, 1.06]	0.80	[0.45, 1.43]	0.95	[0.55, 1.63]
Grade Level	1.29 *	[1.01, 1.64]	1.23	[0.69, 2.18]	0.95	[0.56, 1.62]
Male	0.81 *	[0.66, 0.99]	2.35 ***	[1.51, 3.65]	2.90 ***	[1.94, 4.36]
Black	0.27 ***	[0.19, 0.39]	0.64	[0.35, 1.19]	2.37 **	[1.35, 4.16]
Hispanic	0.47 ***	[0.35, 0.64]	0.76	[0.37, 1.55]	1.61	[0.84, 3.09]
Other	0.52 ***	[0.40, 0.69]	0.75	[0.45, 1.25]	1.43	[0.89, 2.31]
Parental Education	1.01	[0.93, 1.10]	0.93	[0.76, 1.14]	0.92	[0.76, 1.11]
School						
Grade in School	0.99	[0.94, 1.04]	0.94	[0.86, 1.03]	0.95	[0.87, 1.04]
Cut Class Last 2 weeks	0.97	[0.88, 1.08]	1.21	[0.83, 1.76]	1.24	[0.86, 1.79]
Heldback	0.70 *	[0.52, 0.93]	0.71	[0.39, 1.29]	1.01	[0.58, 1.76]
Suspended	1.07	[0.88, 1.31]	1.93 ***	[1.35, 2.77]	1.80 **	[1.28, 2.53]
Social Interaction						
Times Out Per Week	0.89 ***	[0.83, 0.94]	1.11	[0.97, 1.28]	1.26 ***	[1.11, 1.43]
Community Service	1.01	[0.91, 1.12]	1.00	[0.81, 1.24]	0.99	[0.81, 1.21]
Sports Participation	0.96	[0.91, 1.03]	1.14	[0.99, 1.32]	1.19 *	[1.04, 1.36]
Solitary Leisure	1.04	[0.94, 1.14]	0.77 **	[0.66, 0.90]	0.74 ***	[0.65, 0.85]
Parental Involvement	0.82 *	[0.69, 0.96]	0.52 ***	[0.39, 0.71]	0.64 **	[0.50, 0.83]
Sensation Seeking	0.40 ***	[0.36, 0.46]	0.00 ***	[0.00, 0.01]	0.01 ***	[0.00, 0.02]
Substance Use						
2-week Binge Drinking	1.22	[0.83, 1.78]	2.79	[0.93, 8.35]	2.30	[0.81, 6.53]
30-Day Marijuana Use	1.04	[0.97, 1.12]	1.34 *	[1.06, 1.68]	1.28 *	[1.03, 1.60]
Past 12-month Drug Use	1.31	[0.95, 1.79]	2.12 *	[1.02, 4.38]	1.62	[0.82, 3.21]

Note: Adjusted odds ratios from the final 5-profile model using NA+PA and moderate NA as reference groups. AOR = adjusted odds ratio; 95%CI = 95% confidence interval

*p < .05

**p < .01

***p < .001

Table 21. LPA Model Fit Statistics by Gender, Chapter 4

Sample	k	p	LL	SABIC	AIC	CAIC	LMR LRT	Entropy
Males								
(*n* = 23,457)	1	20	-151145.75	302429.19	302331.49	302398.90	-	-
	2	26	-146684.70	293548.40	293421.39	293509.02	8776.74	0.98
	3	32	-143452.26	287124.84	286968.53	287076.37	6359.54	0.91
	4	38	-141586.30	283434.22	283248.59	283376.66	3671.13	0.91
	5	**44**	**-139735.87**	**279774.68**	**279559.74**	279708.03	**3640.56**	**0.89**
	6	50	-137140.77	274625.78	274381.53	274550.05	3192.80	0.94
	7	56	-136101.87	272589.30	272315.74	272504.48	2043.94	0.95
	8	-	-	-	-	-	-	-
Females								
(*n* = 24,439)	1	20	-157471.29	315081.10	314982.58	315050.35	-	-
	2	26	-154994.92	310169.92	310041.84	310129.93	4872.37	0.79
	3	32	-152563.32	305348.27	305190.64	305299.06	4784.28	0.87
	4	38	-151032.96	302329.10	302141.92	302270.66	3011.06	0.83
	5	**44**	**-149815.70**	**300075.97**	**299719.40**	299868.48	**2395.01**	**0.84**
	6	50	-149010.37	298367.05	298120.75	298290.15	1584.52	0.83
	7	56	-148424.50	297236.86	296961.01	297150.74	933.24	0.84
	8	62	-147981.41	296392.24	296086.83	296296.89	871.80	0.78

Note: Fit statistics for the1 through 8-profile models. LL = Log-likelihood; p = number of parameters; k = number of profiles; SABIC = sample size adjusted Bayesian Information Criterion; AIC = Aikake's Information Criterion; CAIC = Consistent AIC; LMR LRT = Vuong-Lo-Mendell-Rubin likelihood ratio test; All LMR LRT values significant at $p < .001$. Final model statistics are shown in bold.

Table 22. LPA Fit Statistics for the Gender Similarity Models, Chapter 4

Model	k	p	LL	SABIC	AIC	CAIC	D
Configural	5	74	-322934.70	646431.71	646017.40	646289.74	-
Structural	5	49	-323894.50	648161.34	647887.00	648067.34	1210.71
Distributional	5	70	-323136.86	646805.64	646413.73	646671.35	201.33

Note: Fit statistics for the1 through 8-profile models. LL = Log-likelihood; p = number of parameters; k = number of profiles; SABIC = sample size adjusted Bayesian Information Criterion; AIC = Aikake's Information Criterion; CAIC = Consistent AIC; D = Likelihood Ratio Difference Test Statistic. All D values significant at $p < .001$.

Table 23. LPA Indicator Means by Gender and Profile, Chapter 4

				Indicator Means (M)				
Profile	Gender	n	%	Anhedonia	Depress	Anxiety	Boredom	Anger
Low NA	Males	14314	30%	1.31	1.55	2.57	2.97	2.36
	Females	13371	28%	1.40	1.58	3.01	3.11	2.31
Moderate NA	Males	5271	11%	2.84	2.93	3.27	3.59	2.82
	Females	6518	14%	2.92	3.06	3.84	3.80	3.08
High NA	Males	1096	2%	4.35	4.30	3.92	4.29	3.16
	Females	2362	5%	4.36	4.27	4.39	4.28	3.34
NA+PA	Males	1446	3%	1.42	3.95	3.56	3.87	3.21
	Females	1908	4%	1.57	3.74	3.58	3.88	3.40
Numb	Males	1053	2%	4.90	1.11	1.42	1.56	1.43
	Females	559	1%	4.83	1.26	1.78	1.91	1.71

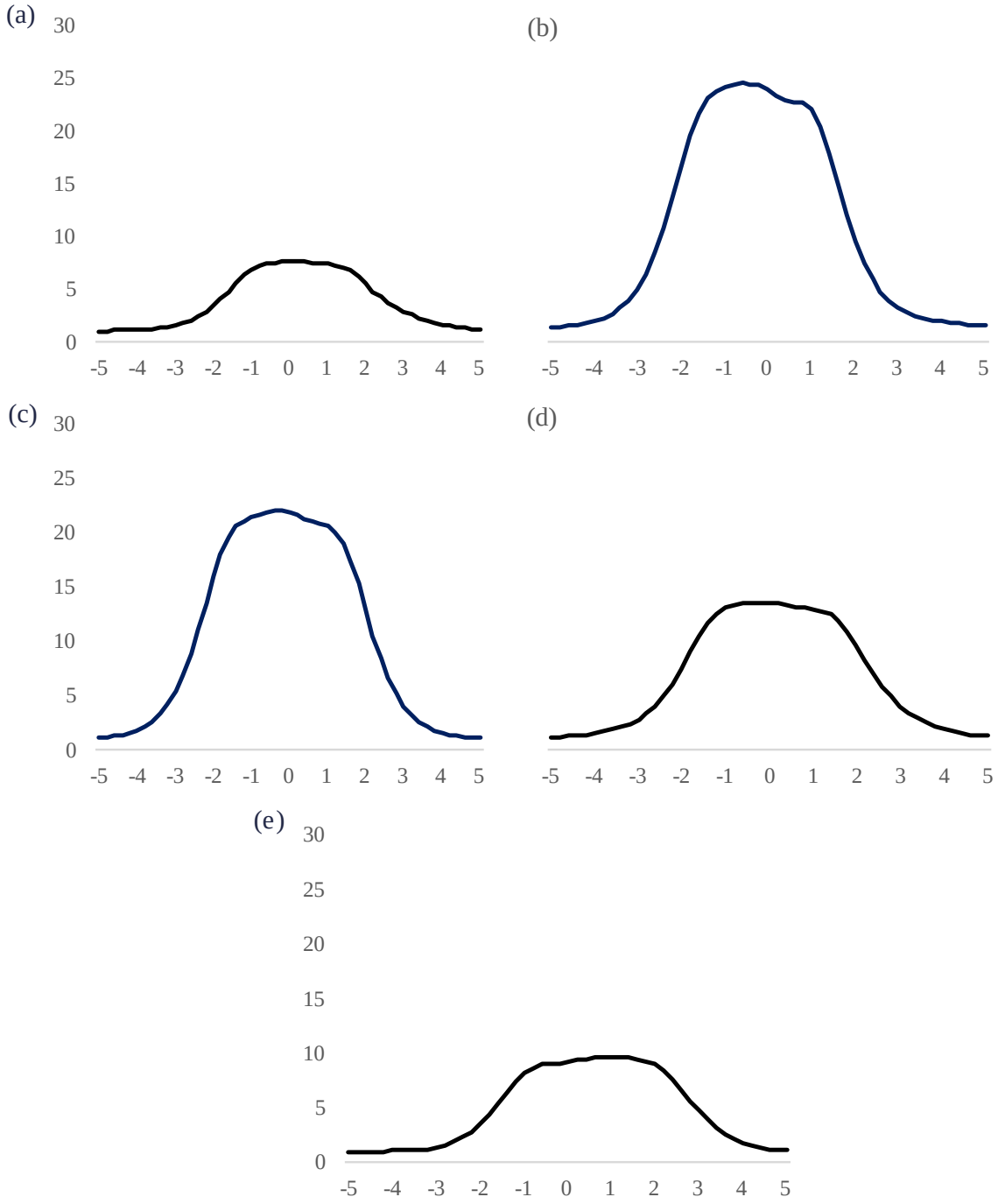
Note: Values come from the configural similarity model wherein means and proportions were free to differ across gender. Standard deviations were constrained to be equal across groups and profiles. Depress = depressive affect; NA = negative affect, PA = positive affect.

Table 24. LPA Final Gender Model Classification Statistics, Chapter 4

	AvePP					OCC
	Low NA	Mod NA	High NA	NA+PA	Numb	
Females						
Low NA	**0.93**	0.04	0.00	0.03	0.00	33.29
Mod NA	0.05	**0.90**	0.04	0.02	0.00	55.89
High NA	0.00	0.09	**0.91**	0.00	0.01	188.03
NA+PA	0.14	0.05	0.00	**0.81**	0.00	104.09
Numb	0.00	0.01	0.03	0.00	**0.96**	2088.65
Males						
Low NA	**0.93**	0.04	0.00	0.03	0.00	31.17
Mod NA	0.04	**0.92**	0.02	0.01	0.00	94.33
High NA	0.00	0.09	**0.90**	0.01	0.00	415.77
NA+PA	0.08	0.06	0.00	**0.86**	0.00	195.37
Numb	0.00	0.01	0.01	0.00	**0.98**	2093.54

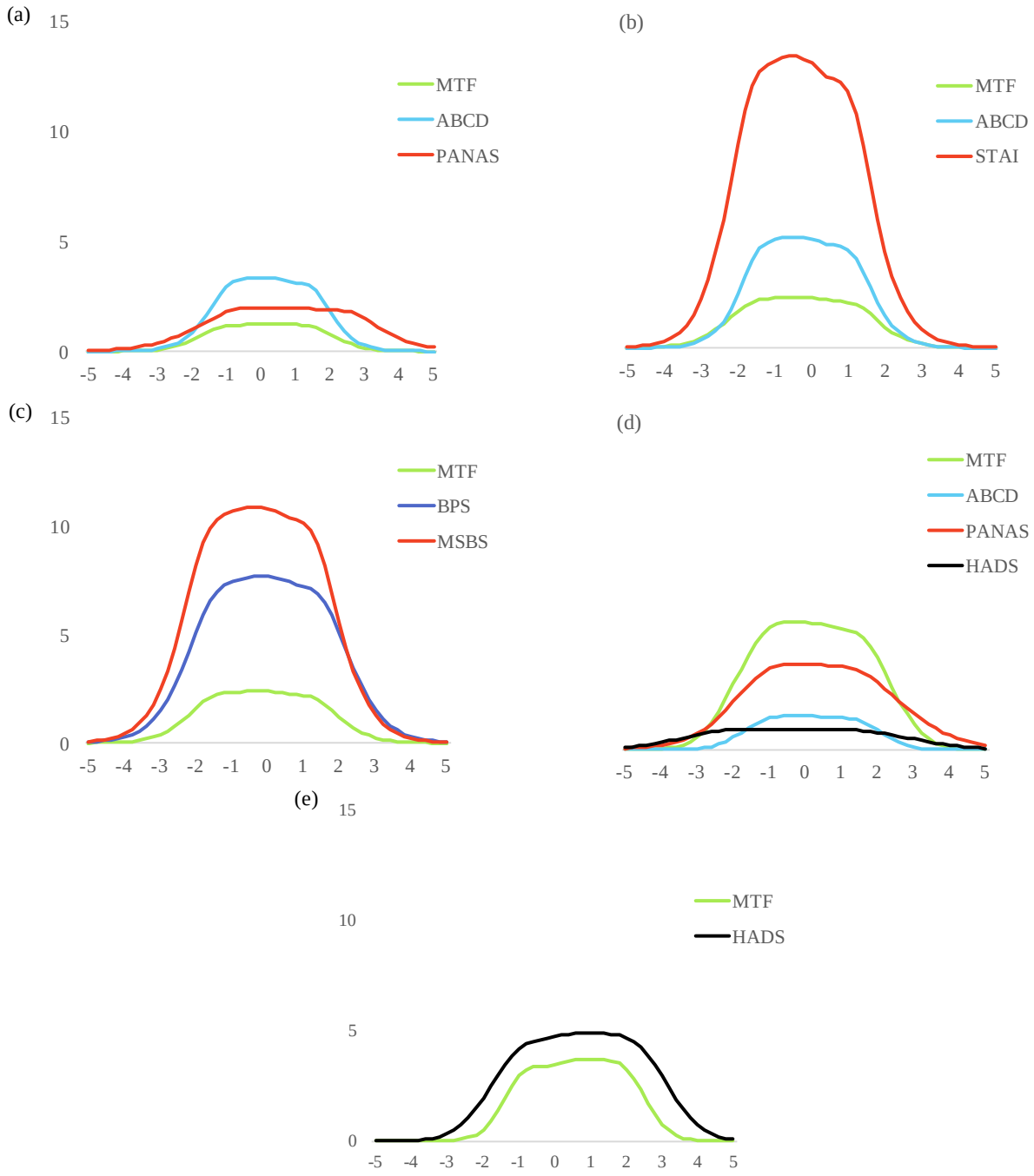
Note. AvePP = Average posterior class probability; OCC = odds of correct classification; NA = negative affect; PA = positive affect. AvePP values for each class shown in bold.

Figure 1. Test Information Functions, Chapter 2



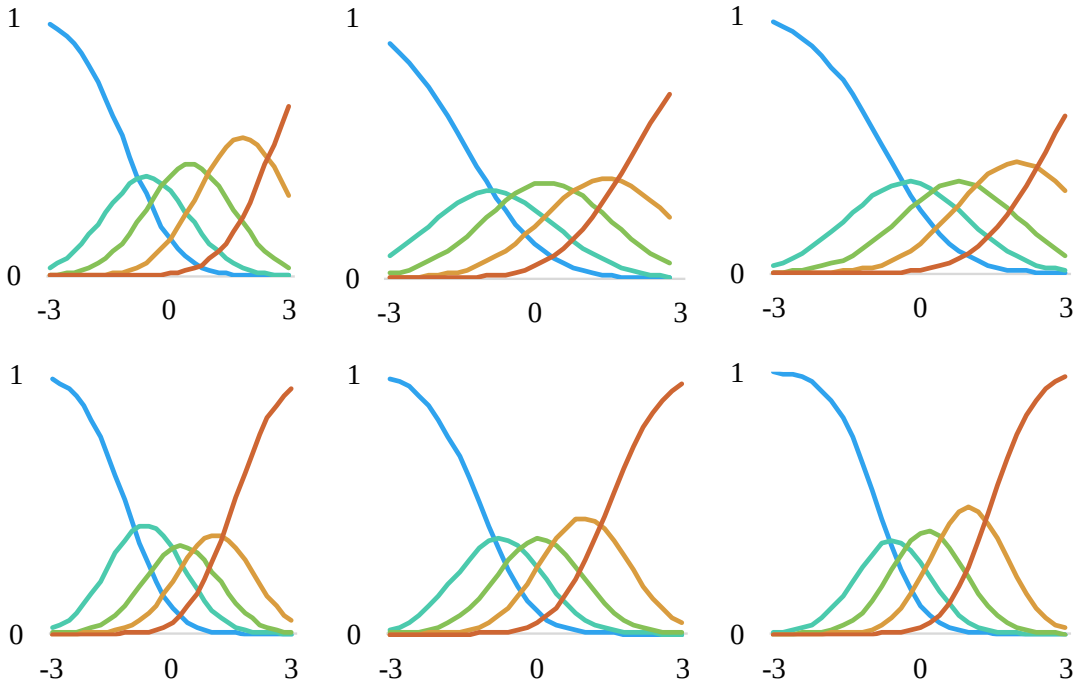
Note: Total information provided by each scale for (a) anger, (b) anxiety, (c) boredom, (d) depression, (e) anhedonia.

Figure 2. Partial Test Information Functions, Chapter 2



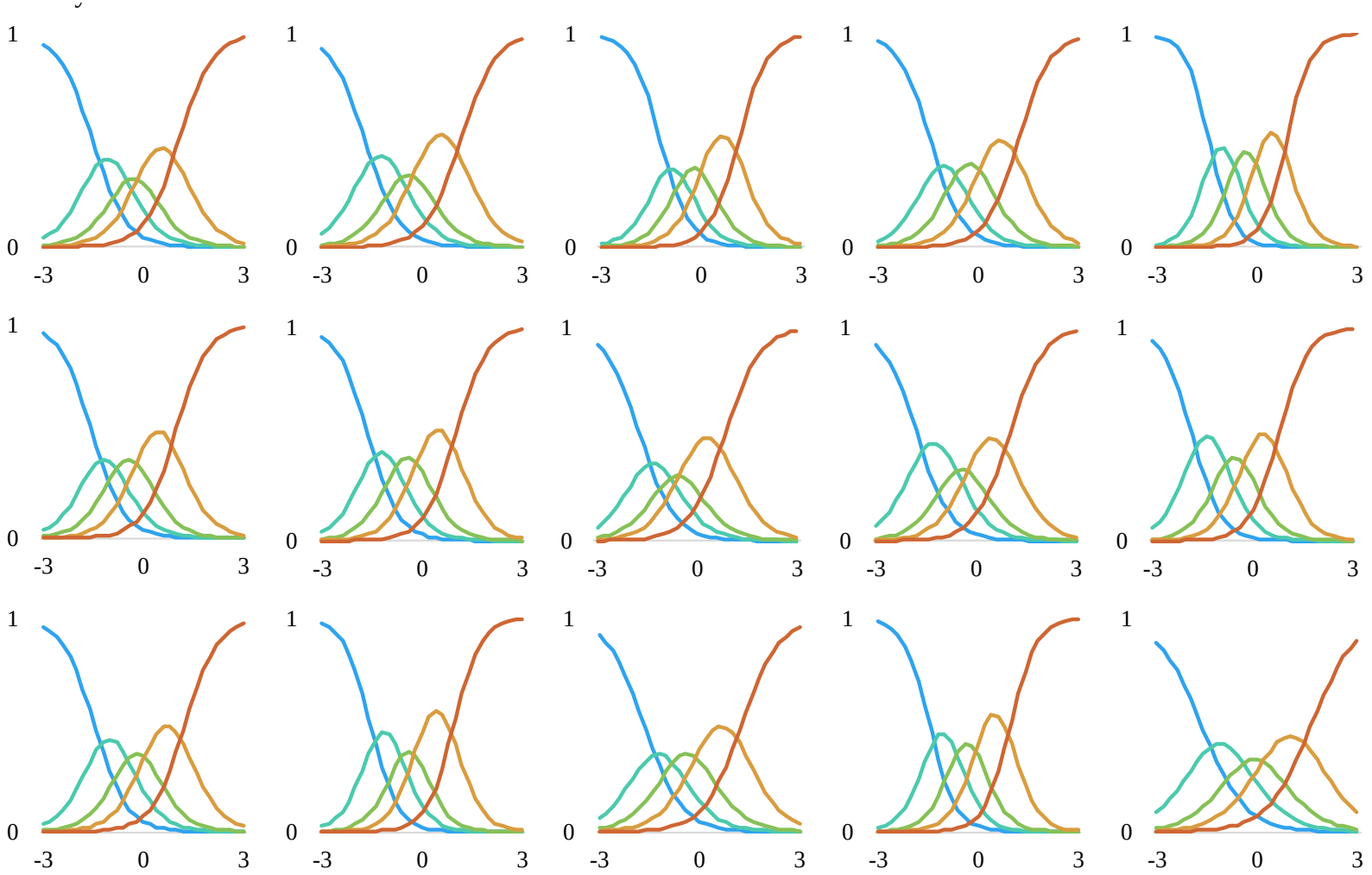
Note: Total amount of information provided by the items of each scale for (a) anger, (b) anxiety, (c) (d) depression, and (e) anhedonia.

Figure 3. Anger Item Information Curves, Chapter 2



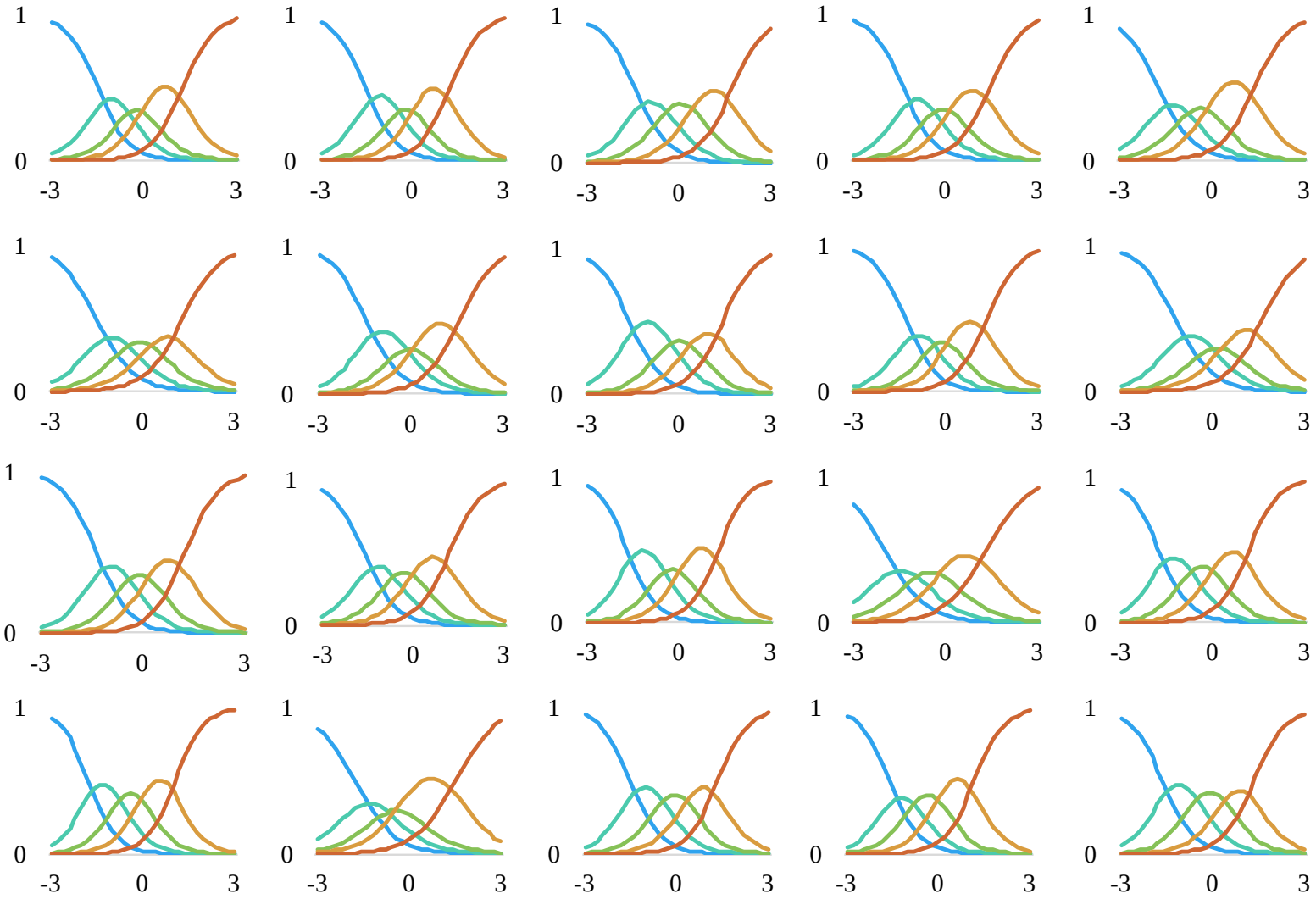
Note: Amount of information provided by each items' response option across levels of θ. in order left to right, starting with ang1 (top left) and ending with ang6 (bottom right).

Figure 4. Anxiety Item Information Curves, Chapter 2



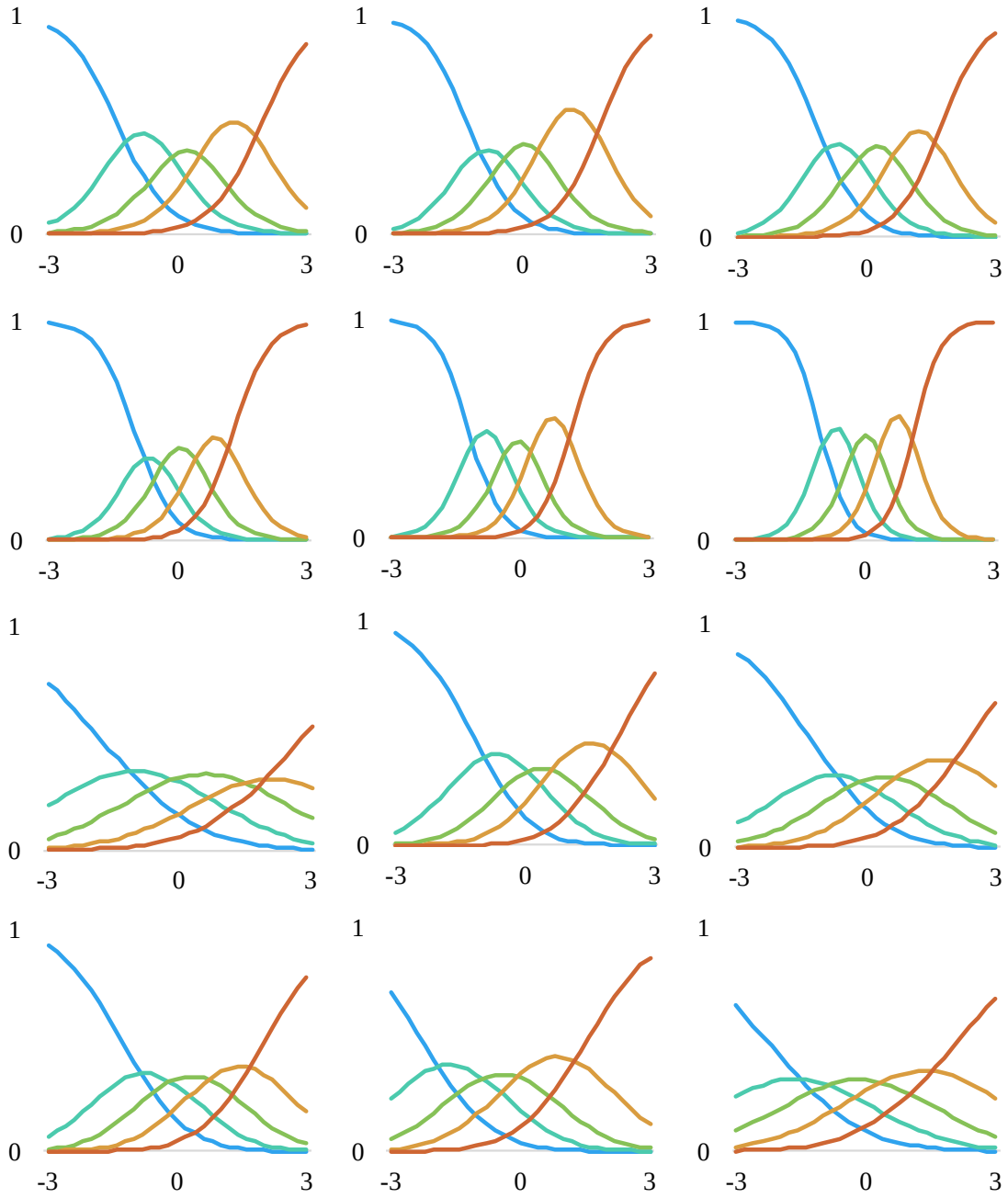
Note: Amount of information provided by each items' response option across levels of θ. Presented in order left to right, starting with anx1 (top left) and ending with anx15 (bottom right).

Figure 5. Boredom Item Information Curves, Chapter 2



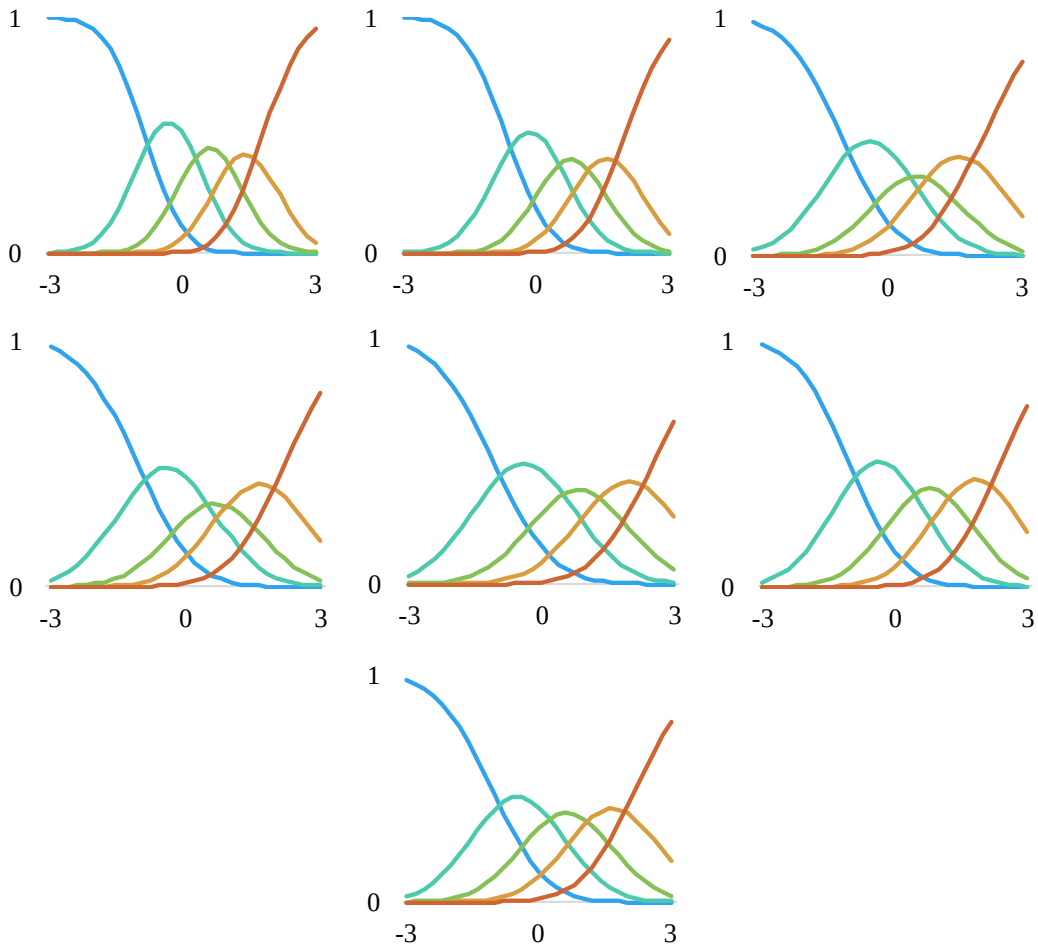
Note: Amount of information provided by each items' response option across levels of θ. Presented in order left to right, starting with b1 (top left) and ending with b20 (bottom right).

Figure 6. Depression Item Information Curves, Chapter 2



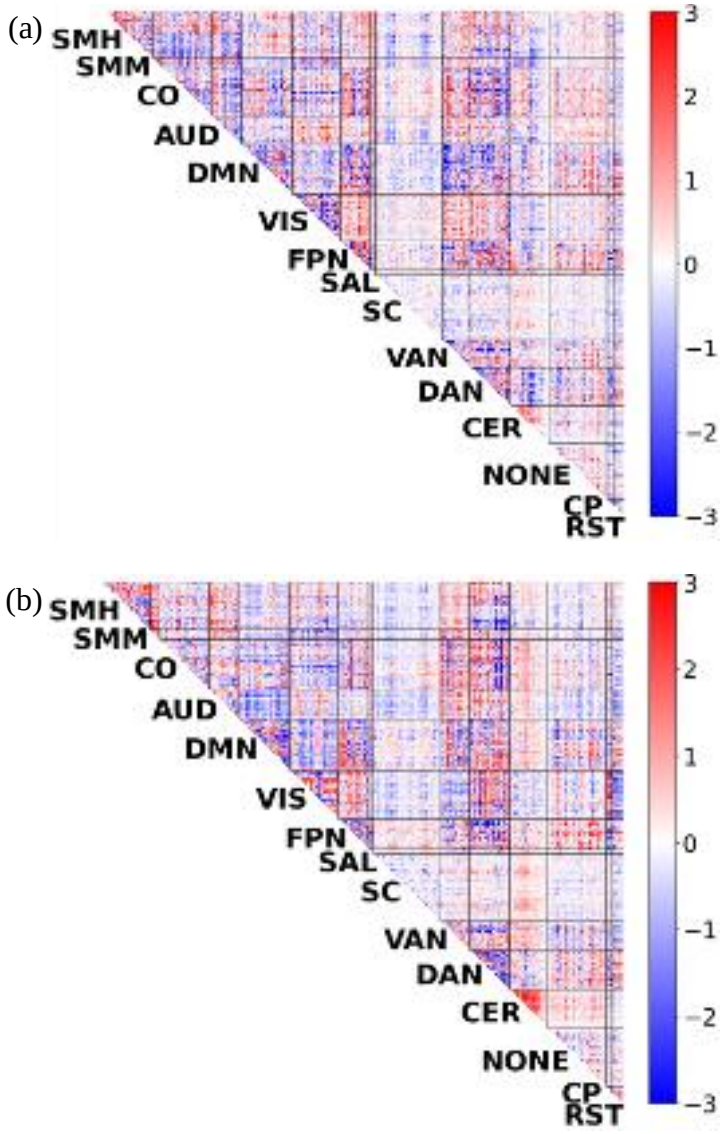
Note: Amount of information provided by each items' response option across levels of θ. Presented in order left to right, starting with d1 (top left) and ending with d12 (bottom right).

Figure 7. Anhedonia Item Information Curves, Chapter 2



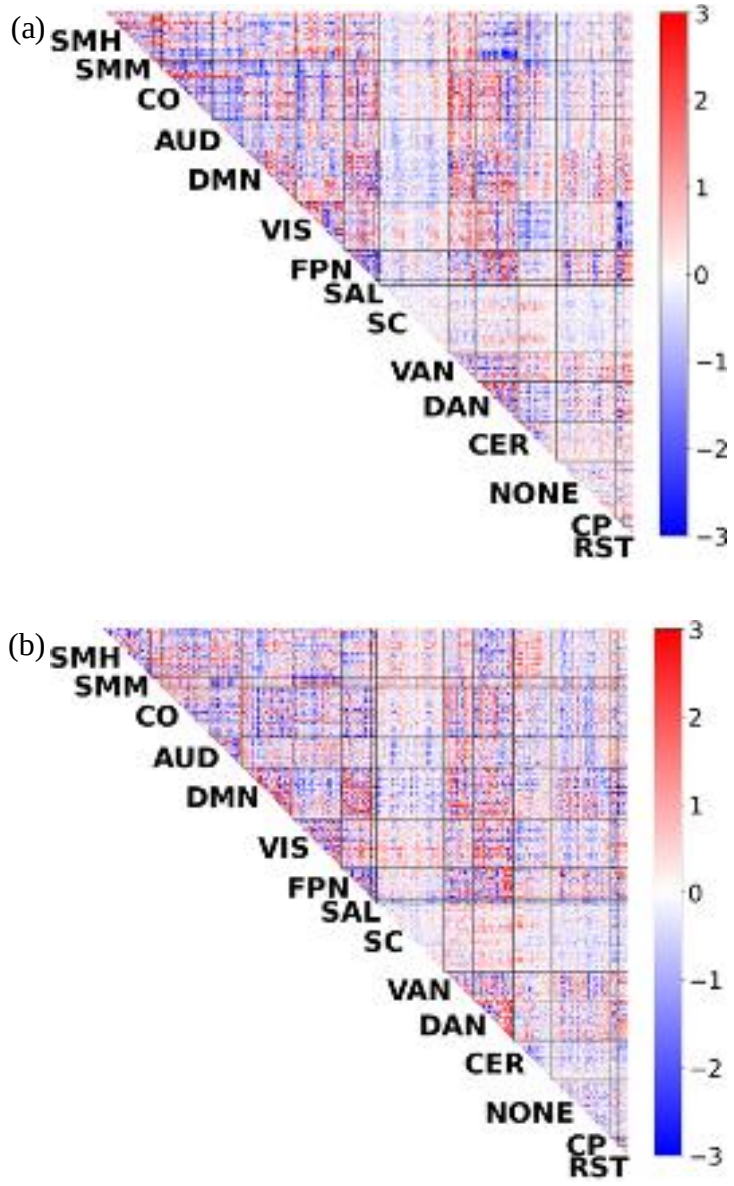
Note: Amount of information provided by each items' response option across levels of θ. Presented in order left to right, starting with a1 (top left) and ending with a7 (bottom center).

Figure 8. Urgency Consensus Maps, Chapter 3



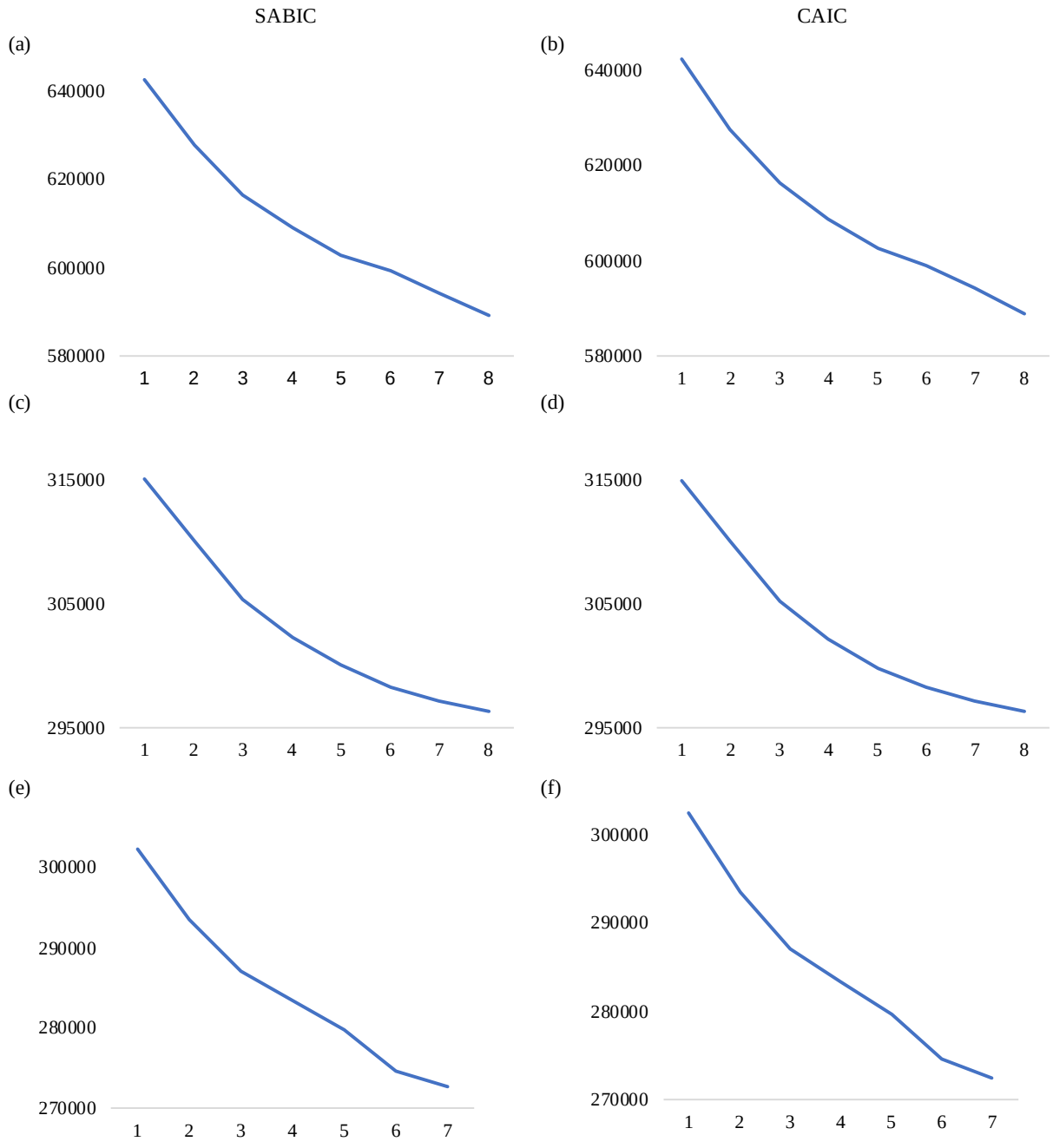
Note: Consensus maps that summarize functional connectivity patterns between brain networks that contribute to a) positive urgency and b) negative urgency; SMH = Somatomotor Hand; SMM = Somatomotor-Mouth; CO = Cingulo-Opercula; AUD = Auditory; DMN = Default Mode; VIS = Visual; FPN = Frontoparietal; SAL = Salience; SC = Subcortical; VAN = Ventral Attention; DAN = Dorsal Attention; CER = Cerebellum; NONE = Not Named; CP = Cingulo-Parietal; RST = Retrosplenial Temporal.

Figure 9. Behavioral Impulsivity Consensus Maps, Chapter 3



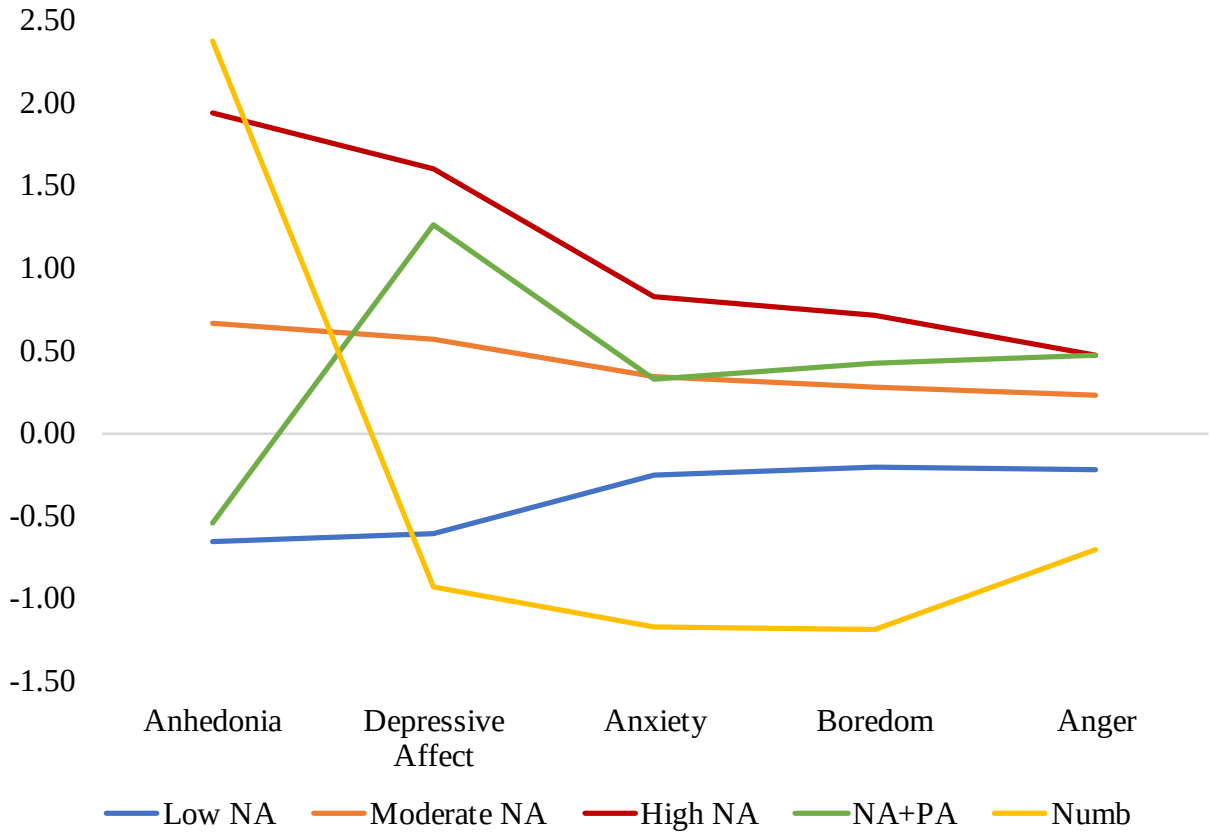
Note: Consensus maps that summarize functional connectivity patterns between brain networks that contribute to a) lack of premeditation and b) lack of perseverance; SMH = Somatomotor Hand; SMM = Somatomotor-Mouth; CO = Cingulo-Opercula; AUD = Auditory; DMN = Default Mode; VIS = Visual; FPN = Frontoparietal; SAL = Salience; SC = Subcortical; VAN = Ventral Attention; DAN = Dorsal Attention; CER = Cerebellum; NONE = Not Named; CP = Cingulo-Parietal; RST = Retrosplenial Temporal.

Figure 10. SABIC and CAIC Elbow Plots for LPA Enumeration Stage, Chapter 4



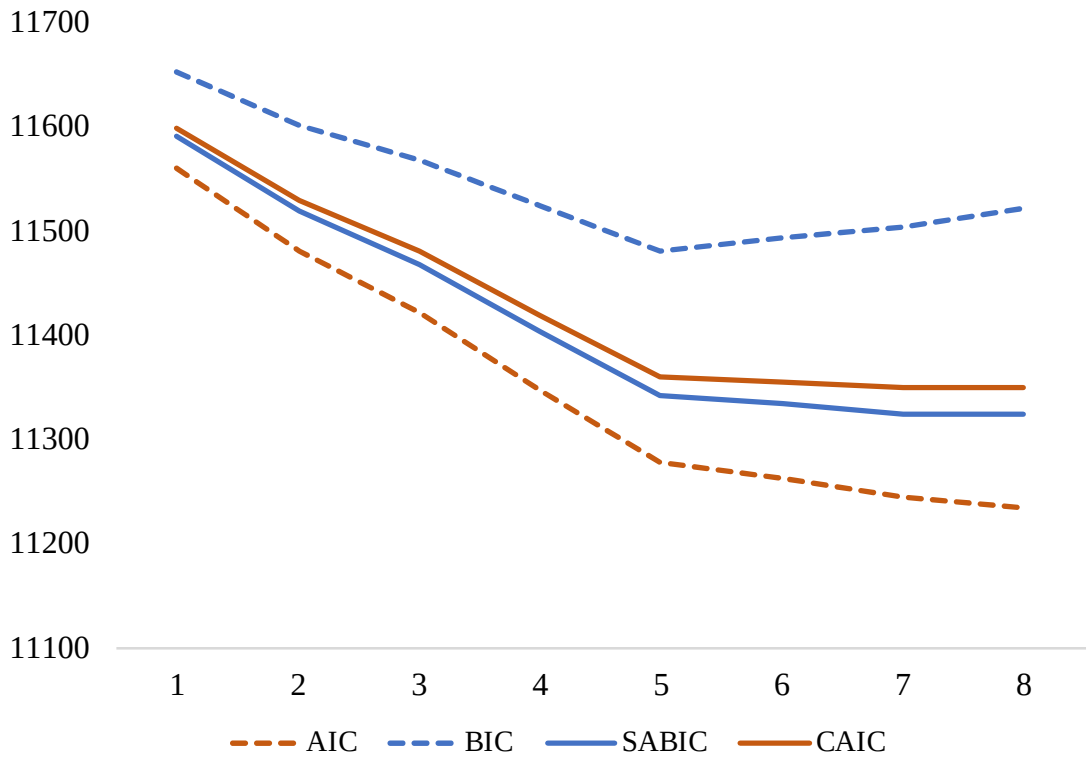
Note: Elbow plots of the sample size adjusted baysian information criterion (SABIC) and Consistent AIC (CAIC)across profile solutions for the full sample models (a & b), the female sample models (c & d), and the male sample models (e & f). The 8 profile solution for the male sample did not converge.

Figure 11. Standardized Indicator Means by Latent Profile, Chapter 4



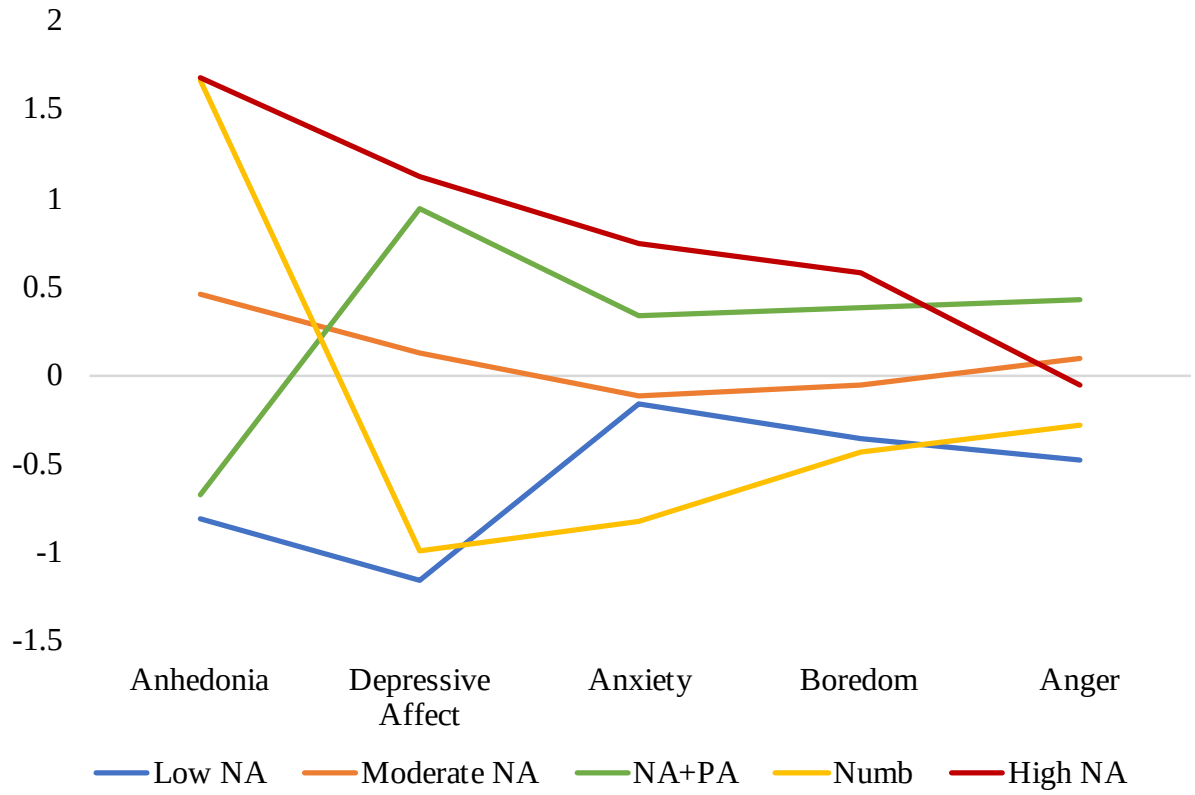
Note: Standardized indicator means for the low NA (blue), moderate NA (orange), high NA (red), NA+PA (green), and numb (yellow) profiles.

Figure 12. Elbow Plot of Relative Fit Statistics for the Validation Model, Chapter 4



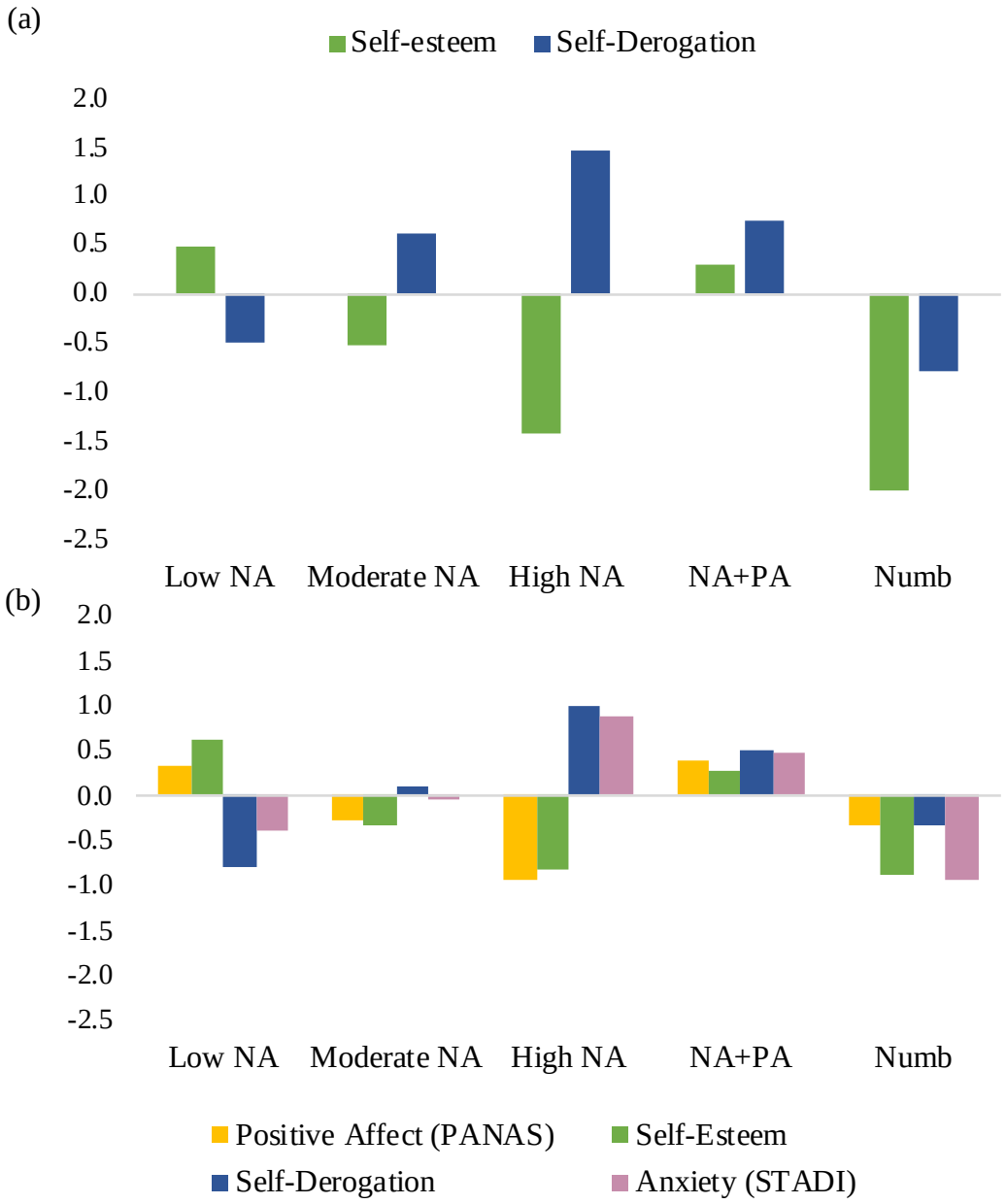
Note: Relative fit statistics for the young adult sample (N+753). BIC = Bayesian Information Criterion; SABIC = sample size adjusted Bayesian Information Criterion; AIC = Aikake's Information Criterion; CAIC = Consistent Aikake's Information Criterion.

Figure 13. Standardized Indicator Means by Latent Profile in the Validation Sample, Chapter 4



Note: Replication of the original LPA model in an independent young adult sample (N = 753).

Figure 14. Latent Profile Validation, Chapter 4



Note: The standardized profile means for (a) self-esteem and self-derogation for the MTF model (N = 49,346) and (b) self-esteem, self-derogation, positive affect, and anxiety in the YA sample (N = 753). PANAS = Positive and Negative Affect Schedule; STADI = State Trait Anxiety and Depression Inventory.

Figure 15. Standardized School Misbehavior and Sensation Seeking Means by Latent Profile, Chapter 4

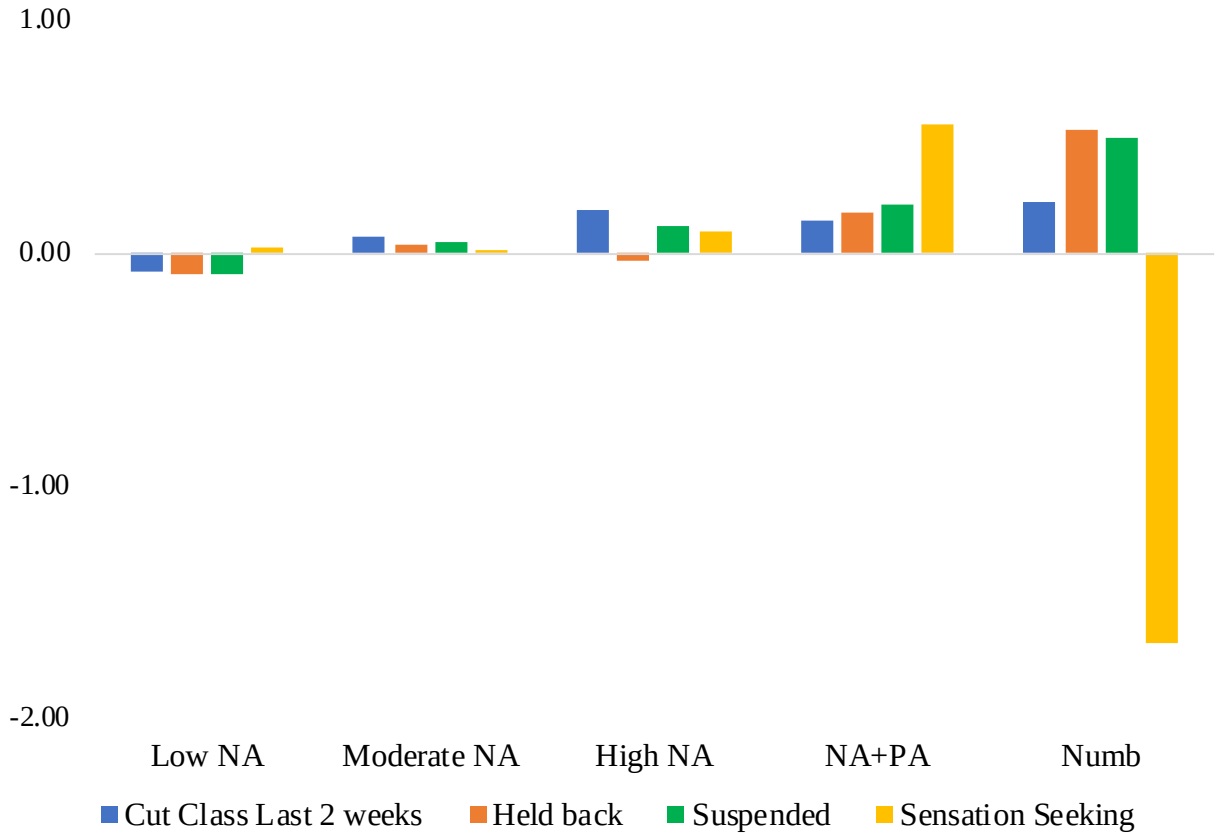


Figure 16. Standardized Social Interaction Means by Latent Profile, Chapter 4

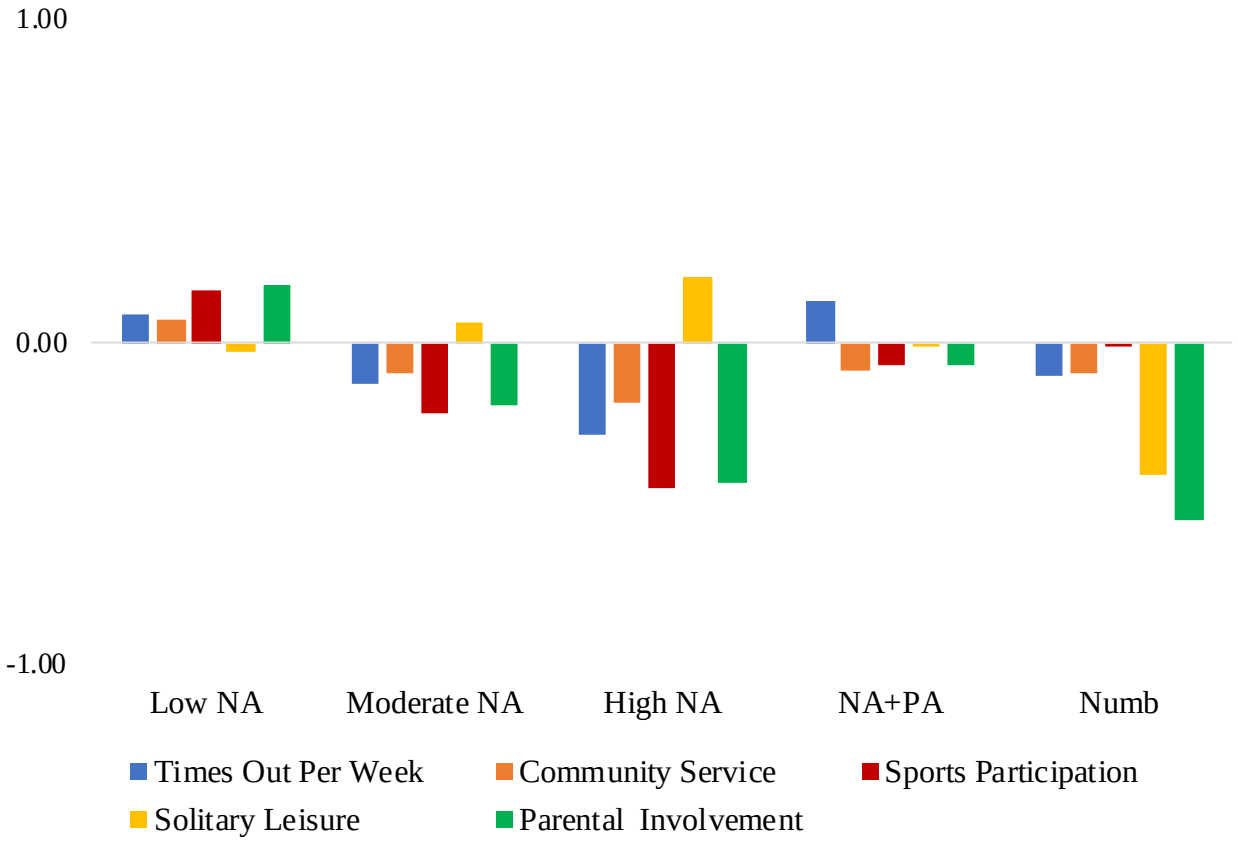
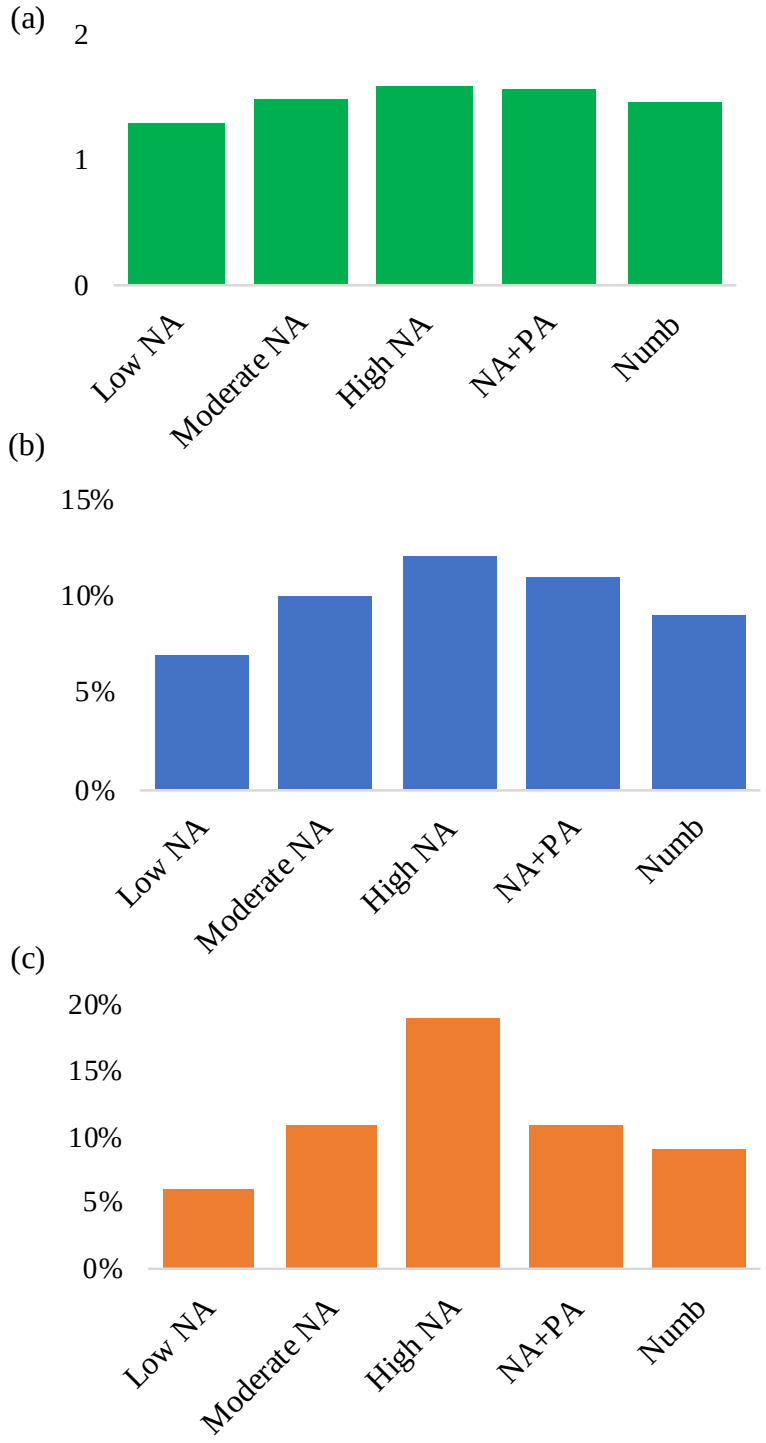
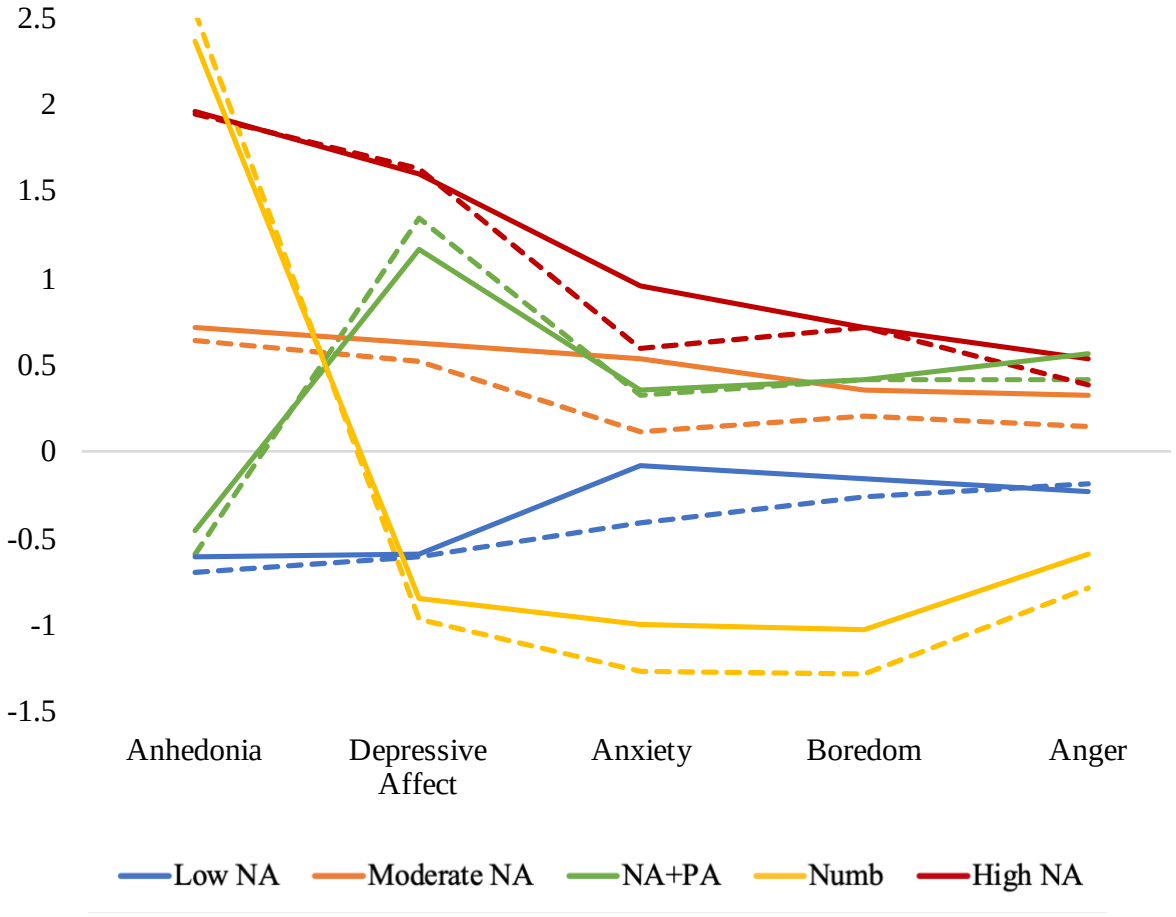


Figure 17. Substance Use Means and Proportions, Chapter 4



Note: Profile means for (a) marijuana use. Proportion of sample reporting (b) past 2-week binge drinking, and (c) drug use other than marijuana. NA = negative affect; PA = positive affect.

Figure 18. Standardized Indicator Means from the Configural Gender Model, Chapter 4



Note: Standardized indicator means for males (dashed lines) and females (solid lines) in the low NA (blue), moderate NA (orange), high NA (red), NA+PA (green), and numb (yellow) profiles.

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Appendix A

Supplemental Anhedonia Validity Analysis

Table 25. A1 Factor Correlations from Supplementary Analysis

		1	2	3	4	5	6	7	8	9	10
1	$ANHD_{MTF}$	1									
2	$ANHD_{HADS}$	0.86***	1								
3	SHAPS	0.58***	0.82***	1							
4	Pos. Affect	-0.62***	-0.53***	-0.39***	1						
5	SE_{MTF}	-0.81***	-0.82***	-0.66***	0.88***	1					
6	SD_{MTF}	0.31***	0.24***	0.13*	-0.24***	-0.35***	1				
7	$Depress_{MTF}$	0.18**	0.12	0.07	-0.14*	-0.21**	0.78***	1			
8	$Anxiety_{MTF}$	-0.10	-0.29***	-0.38***	-0.15*	0.01	0.57***	0.48***	1		
9	$Boredom_{MTF}$	0.14*	0.05	-0.04	-0.15**	-0.11	0.58***	0.49***	0.53***	1	
10	$Anger_{MTF}$	-0.04	-0.08	-0.05	0.01	0.11*	0.45***	0.40***	0.35***	0.35***	1

Note: Factor correlations between anhedonia scales, positive affect, and related MTF negative affect measures. Data comes from the Study 1 sample (N=783). ANHD = anhedonia items; MTF = Montioring the Future items; HADS = Hospital Anxiety and Depression Scale; SHAPS = Snaith-Hamilton Pleasure Scale, a measure of anhedonia; Pos. Affect = positive affect items from the Positive and Negative Affect Schedule (PANAS); SE = self-esteem; SD = self-derogation; Depress = depressive affect.

* $p < .05$

** $p < .01$

*** $p < .001$

Appendix B

Study 2 Missing Data and Sensitivity Analyses

Table 26. B1 Descriptive Means by Sample From Missing Data Analysis

		Missing Data Samples		
	Full Sample	None *N* = 3,500	YSR *N* = 3,181	TRF *N* = 7,188
Impulsivity (*N* = 11,850)				
Negative Urgency	2.12 (0.66)	2.11 (0.66)	2.20 (0.66)	2.10 (0.66)
Positive Urgency	2.00 (0.74)	1.97 (0.72)	2.06 (0.76)	1.98 (0.73)
Lack of Premeditation	1.94 (0.59)	1.94 (0.57)	1.96 (0.60)	1.92 (0.59)
Lack of Perseverance	1.76 (0.56)	1.74 (0.54)	1.76 (0.56)	1.75 (0.57)
Youth Self-Report (*N* = 8,708)				
Depression	1.16 (0.35)	1.16 (0.35)	-	1.17 (0.36)
Anxiety	1.42 (0.47)	1.41 (0.46)	-	1.43 (0.48)
Anger	1.54 (0.55)	1.52 (0.54)	-	1.55 (0.55)
Teacher Report Form (*N* = 4,684)				
Depression	1.20 (0.42)	1.20 (0.42)	1.21 (0.41)	-
Anxiety	1.39 (0.48)	1.39 (0.48)	1.40 (0.49)	-
Anger	1.27 (0.51)	1.26 (0.50)	1.30 (0.53)	-

Note: Descriptive means for the full sample, those with no missing data ("None") those missing youth self report negative affect measures (YSR), and those missing teacher report negative affect measures (TRF). Standard deviations are shown in parentheses.

Table 27. B2 Sensitivity Analysis Demographic Characteristics

					Missing Data	
	Model 1	Model 2	Model 3	Model 4	YSR	TRF
	N = 10, 747	*N* = 8,701	*N* = 4,683	*N* = 3,500	*N* = 3,181	*N* = 7,188
Male	52%	53%	51%	51%	49%	53%
Race/Ethnicity						
Black	15%	12%	13%	10%	25%	17%
White	52%	57%	59%	62%	40%	48%
Hispanic	20%	20%	16%	16%	22%	23%
Other	2%	2%	2%	2%	2%	2%
Parental Education						
Bachelor's Degree +	60%	63%	65%	67%	50%	56%
Parental Income						
< 50K	30%	27%	24%	22%	38%	33%
50K - 100K	28%	29%	29%	30%	25%	28%
> 100K	42%	44%	47%	48%	37%	39%
Mental Health Diagnosis						
No MHC	45%	45%	45%	45%	45%	45%
IO	22%	22%	22%	22%	22%	22%
EO	13%	13%	13%	13%	13%	14%
IxE	20%	20%	20%	20%	20%	20%

Note: Demographic characteristics of each sample used in the sensitivity analysis, and those of the missing data samples. Models differ by which predictors are included; Model 1, individuals missing data on impulsvity and demographics are excluded; Model 2, individuals missing data on impulsvity, demographics, and youth self-report negative affect are excluded; Model 3, individuals missing data on impulsvity, demographics, and teacher report negatiev affect are excluded; Model 4, individuals missing data on impulsvity, demographics, and either self or teacher report negative affect are excluded. YSR = youth self-report, TRF = teacher report form, No MHC = no mental health diagnoses , IO = internalizing only , EO = externalizing only , IxE = heterotypic comorbidity.

Table 28. B3 Logits From Study 2 Sensitivity Analysis

	Reference Group	No MHC			IxE		IO
	Comparison Group	IO	EO	IxE	IO	EO	EO
Model 1	Negative Urgency	-0.02	0.21***	0.27***	-0.29***	-0.06	0.23***
(N = 10,747)	Positive Urgency	-0.03	0.02	0.10*	-0.13**	-0.09	0.05
	Lack of Premeditation	-0.11*	0.22***	0.18***	-0.28***	-0.04	0.33***
	Lack of Perseverance	0.23***	0.38***	0.47***	-0.24***	-0.09	0.15*
Model 2	Negative Urgency	-0.04	0.17**	0.16**	-0.20**	0.01	0.21**
(N = 8,701)	Positive Urgency	-0.05	0.01	0.05	-0.10	-0.04	0.07
	Lack of Premeditation	-0.1	0.26***	0.18**	-0.28***	0.07	0.36***
	Lack of Perseverance	0.19***	0.36***	0.39***	-0.20**	-0.04	0.16*
	YSR - Depression	-0.06	0.17	0.39***	-0.45***	-0.22	0.22
	YSR - Anxiety	0.35***	-0.05	0.23**	0.12	-0.28**	-0.40***
	YSR - Anger	-0.04	0.47***	0.42***	-0.46***	0.04	0.50***
Model 3	Negative Urgency	-0.10	0.11	0.24**	-0.34***	-0.13	0.21*
(N = 4684)	Positive Urgency	-0.01	0.12	0.08	-0.09	0.04	0.13
	Lack of Premeditation	-0.18*	0.11	0.15	-0.34**	-0.05	0.29**
	Lack of Perseverance	0.25**	0.27**	0.33***	-0.08	-0.06	0.02
	TRF - Depression	-0.02	0.45**	0.33*	-0.35*	0.12	0.47**
	TRF - Anxiety	0.39***	-0.03	0.59***	-0.21	-0.62***	-0.41**
	TRF - Anger	-0.03	0.49***	0.73***	-0.76***	-0.25*	0.51***
Model 4	Negative Urgency	-0.19*	-0.04	0.09	-0.28**	-0.13	0.15
(N = 3,500)	Positive Urgency	0.00	0.19*	0.07	-0.07	0.12	0.19
	Lack of Premeditation	-0.14	0.17	0.17	-0.31**	0.01	0.32*
	Lack of Perseverance	0.30**	0.27*	0.31**	-0.01	-0.04	-0.03
	YSR - Depression	-0.28	0.12	0.21	-0.49**	-0.09	0.40
	YSR - Anxiety	0.26*	-0.06	0.29*	-0.03	-0.35*	-0.32*
	YSR - Anger	0.11**	0.38**	0.30**	-0.19	0.08	0.27*
	TRF - Depression	-0.11	0.45*	0.20	-0.31	0.25	0.56**
	TRF - Anxiety	0.42**	0.04	0.55***	-0.13	-0.51**	-0.38*
	TRF - Anger	-0.02	0.48***	0.74***	-0.76***	-0.25*	0.50**

Note: Logits from multinomial logistic regression sensitivity analyses comparing mental health diagnosis prediction models. Model 1 predictors = impulsivity, Model 2 predictors = impulsivity and youth self report negative affect, Model 3 predictors= impulsivity and teacher report negative affect, Model 4 = Final model presented in Study 2; impulsivity, youth self-report negative affect, and teacher report negative affect as predictors. All models include gender, race, income, and parental education as covariates. No MHC = no mental health condition, YSR = youth self-report form, TRF = teacher report form, no MHC = no mental health diagnosis, IO = internalizing diagnosis only, EO = externalizing diagnosis only, IxE = heterotypic comorbidity.

* $p < .05$
** $p < .01$
*** $p < .001$