New phenotypes for ADHD heterogeneity: traits and change in adolescence

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1. Acknowledgements

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2. Abstract

BACKGROUND: Attention-Deficit/Hyperactivity Disorder (ADHD) is defined in the Diagnostic and Statistical Manual of Mental Disorders, 5th Ed. (DSM) by features of inattention, hyperactivity, and impulsivity. However, substantial opportunity remains to sharpen the description of ADHD's multi-dimensional structure. Particularly salient are the need for further articulation of the role of impulsivity and emotional dysregulation in the ADHD phenotype. This study aimed to examine this multidimensionality through selected (a) near-neighbor clinical behavioral domains and (b) dispositional traits, examined cross-sectionally and longitudinally.

METHODS: The sample was 844 children from the Oregon-ADHD-1000, a community-recruited, case-control cohort featuring extensive multi-measure, multi-informant, multi-clinician best-estimate case assignment and over 10 years of annual follow up. Children ranged in age at baseline from 7-13 years. The sample was 62% male, 81% non-Hispanic white. 60% were assigned a baseline diagnosis of ADHD and 40% were typically developing. Average family income was between $75k-100k.

To create a standardized measure of relevant behavioral domains and traits, directly comparable in terms of content, and identically scaled, Q-sort methodology was employed. Seven domain experts used the California Child Q-Sort to create ideal profiles for children who respectively exhibited Inattention, Hyperactivity, Impulsivity, Irritability, and Cognitive Disengagement Syndrome, and in the trait domain, Ego-Resiliency, Ego-Undercontrol, Negative Emotionality, and Behavioral Regulation. Each child was assigned a relational score to each of the prototypes based on their correlational similarity to these composite ideal prototypes. For longitudinal analysis, baseline scores were used to predict a composite across all future years as to whether children subsequently displayed in any year the onset of new psychopathology, substance use, or suicidal ideation.

RESULTS: All prototypes except Inattention demonstrated adequate or better interrater agreement and construct validity. Exploratory factor analysis suggested that two primary factors adequately summarized the 9 (clinical+trait) domains. These two factors were labeled as Undercontrol and Emotional Dysregulation. Undercontrol was comprised of Hyperactivity, Impulsivity, Ego-Undercontrol, and (low) Behavioral Regulation. Emotional Dysregulation was comprised of Negative Emotionality, (low) Ego-Resiliency, and Irritability.

Cross-sectionally, and unsurprisingly, both factors correlated well with ADHD (β=.519, SE = .043, $p<.001$ for Undercontrol factor; β=.252, SE = .041, $p<.001$ for Emotional Dysregulation factor), and Oppositional Defiant Disorder (ODD) (β=.430, SE = .066, $p<.001$ for Undercontrol Factor, β=.325, SE =.062, $p<.001$ for Emotional Dysregulation factor). Anxiety disorders were

associated negatively with Undercontrol (β=-.355, SE = .066, p<.001) and with Emotional Dysregulation (β=.437, SE =.058, p<.001).

Longitudinally, baseline scores predicted outcomes after controlling for baseline ADHD, ODD, sex and family income as a proxy for socioeconomic status. Undercontrol significantly predicted the slope of ADHD-inattentive symptom trajectory between the ages of 8-18 (β=.185, SE = .045, p<.001). It also predicted whether there was ever a future onset of new disruptive disorders between baseline and age 18 years (β=.398, SE = .094, p<.001), and severity of suicidal thoughts measured on a 0-4 scale between baseline and ages 17-18 (β=.234, SE = .045, p<.001). Emotional Dysregulation negatively predicted likelihood of marijuana usage at any point after baseline (β=-.208, SE =.073, p<.004) after controlling for baseline ADHD and ODD.

CONCLUSIONS. This study contributes to the growing literature advocating for a dimensional approach to ADHD phenotyping, aligning with the Research Domain Criteria (RDoC) framework. By refining the ADHD phenotype through dimensional models and self-regulatory trait frameworks, we aim to inform more personalized assessment, treatment, and intervention strategies, potentially leading to improved outcomes for affected individuals. The finding suggest that both an account of impulsivity (captured in the undercontrol factor) and of emotional dysregulation in the ADHD phenotype or the ADHD population, can significantly enhance clinical assessment and prediction. Future work should continue to refine these approaches.

3. Introduction

3.1. Attention-Deficit/Hyperactivity Disorder: History and Importance

Attention-Deficit/Hyperactivity Disorder, or ADHD, is an exemplar of the need for improved, dimensionally defined phenotypes to help in resolving heterogeneity in developmental psychopathology. ADHD is a neurodevelopmental disorder diagnostically defined as having excessive difficulties with inattentiveness, hyperactivity/impulsivity, or, in its most common presentation, challenges with both. Signs of ADHD typically appear in early childhood and persist through adulthood (American Psychiatric Association, 2022; Sibley et al., 2017).

ADHD's estimated prevalence in children between 5-19 worldwide is between 3%-4% (Erskine et al., 2013) although rates of clinical identification in the United States significantly exceed that estimate (Danielson et al., 2024). In childhood, the ratio of incidence is 4:1 male to female, evolving to approach 1:1 in adulthood (Abdelnour et al., 2022). ADHD is associated with poorer life and health outcomes than non-ADHD or typically developing youth in nearly every domain (Arnold et al., 2020; Harpin et al., 2016; O'Neill et al., 2017). It appears to be causally involved in subsequent depression (Riglin et al., 2021) and anxiety (Gair et al., 2021), and is also associated with later conduct problems, substance use (S. Lee et al., 2011; Vilar-Ribó et al., 2021), alcoholism (Di Lorenzo et al., 2021), and premature death by accident or suicide (Shoval et al., 2021; Sun et al., 2019).

The diagnostic criteria of ADHD have changed somewhat over the past half-century, which in turn has likely had influence as to the population who receive or do not receive the diagnosis. The core meanings and speculated etiology of conditions related to contemporary ADHD have varied widely since their initial conceptualization in the DSM-II, including and

excluding foci on bodily and mental hyperactivity, inattentiveness, and impulsivity at various times throughout the history of its diagnostic criteria. The present paper aims to contribute to the ongoing evolution of our understanding of ADHD by exploring its scope and constituent traits.

3.1.1. A Brief History of ADHD

While ADHD is in many respects a modern disorder in regard to its prevalence and visibility (Danielson et al., 2024) its roots and history can be traced to before the Common Era in the West. References to challenges with attention and overactivity have been found dating back to Hippocrates (460-375 BCE), who described most-likely adult patients who experienced a constellation of symptoms that align with our current conception of the disorder: "quickened responses to sensory experience, but also less tenaciousness because the soul moves on quickly to the next impression." To treat, he suggested various dietary and exercise interventions to treat the symptoms (Martinez-Badía & Martinez-Raga, 2015).

In the more recent history of western psychiatry and psychology, descriptors of pathological inattention and hyperactivity date as far back as 1798 by Sir Alexander Crichton. In a chapter of his treatise on psychological pathology (Crichton, 1798), he specifically described the definition and range of human attention that in some instances bore a resemblance to contemporary ADHD. In the 1840's, a German physician created a book of illustrated morality stories for children entitled *Struwwelpeter* (*Shockheaded Peter*) (Hoffman, 1845). It clearly illustrated children with both inattention ("The Story of Johnny Head-in-Air") and hyperactivity/impulsivity ("The Story of Fidgety Philip"). Of note, in both stories, we see not only the symptoms described, but the functional impact those symptoms may have when left untreated – Johnny Head-in-Air is so taken with looking at the clouds that he doesn't see a dog crossing his path and has a hard fall, while Fidgety Philip infuriates his parents by not only being

unable to sit still at the dining table but also pulling the contents of the set table, food and all, to the ground, leaving them without a meal (Hoffman, 1845).

As far as our contemporary understanding of a concrete diagnosis in medical terminology, Still (1902) was among the first to formally describe symptomatology recognizable in relation to current definitions of ADHD. Even in this early conceptualization, Still's understanding incorporated a component of both attention and disposition. In his descriptors of children with this condition, he highlighted both their attentional challenges as well as their unique temperaments. Still describes a particular group of children as having "an abnormal defect of moral control," and noted that his cases showed "a quite abnormal incapacity for sustained attention" and embodied qualities such as "passionateness", "wanton mischievousness", and "a need for gratification of self without regard either to the good of other or to the larger and more remote good of self" (as quoted in (Lange et al., 2010)).

It is important to consider the economic and educational contexts in which Hoffman wrote his book and in which Still was making these observations, which was in the 82 years since Germany (Prussia) and 30 years since the UK had made formalized education mandatory (Martinez-Badía & Martinez-Raga, 2015). This perhaps led to children who might otherwise been unconstrained by a rigid educational structure in favor of an agrarian lifestyle now required to function in a context reliant on focus, physical stillness, and inhibition to be able to meet the standards of formal education (Hinshaw & Scheffler, 2016). While many these descriptors are only indirectly related to our current formal descriptors of ADHD, they clearly relate to the impulsivity, excitability or hyperactivity, and attentional problems that are emphasized in current diagnostic criteria.

A named diagnosis for symptoms of hyperactivity and inattention independent of any identified physiological disorders (such as symptoms that arose from either the Spanish Flu

(1917-1919) or Encephalitis (1915-1926) pandemics) emerged in England in the 1930's with Kramer and Pollnow's "hyperkinetic disease," which noted urgent, remarkable motor activity, and displeasure when deterred from acting out motor impulses. It notably was often associated with seizures, of which our current understanding of ADHD is not associated with (Kramer & Pollnow, 1930; Neumärker, 2005). Perhaps due to sequelae 1917 encephalitis pandemic (Taylor, 2011), "Minimal Brain Damage" was an early designation (Ross & Ross, 1976). Subsequently, perhaps due to the failure of the mid-century technology to identify brain damage in affected children, the MBD term was instead called "Minimal Brain Dysfunction" (Clements & Peters, 1962; Laufer et al., 1957). In addition to symptoms of inattention and hyperactivity, MBD additionally included symptoms of learning disabilities, anxiety, and emotional dysregulation. While these diagnoses share qualities with current formal diagnostic criteria for ADHD, prior to 1980, formal diagnostic standards were lacking. MBD eventually encompassed a broader spectrum, incorporating what is now described in the DSM (American Psychiatric Association, 2022) as distinct categories of motor, learning, and conduct problems, within the same diagnostic entity. While this DSM approach has had many advantages for research and statistical validity and reliability, for the goal of helping clinicians and clinical evaluation, a better empirical linkage to the many features associated with ADHD is part of the goal of the current project.

The first formal criteria in the United States for child mental conditions, including something like ADHD, were formulated in the Diagnostic and Statistical Manual, second edition (DSM-II). Labelled as "Hyperkinetic Reaction of Childhood" (American Psychiatric Association, 1968), the focus of the descriptor was of physical restlessness and overactivity. At that time, Hyperkinetic Reaction of Childhood was widely (though not exclusively) considered a disorder exclusive to early childhood.

The disorder was reconceptualized in the DSM-III (American Psychiatric Association, 1980), as Attention Deficit Disorder with and without hyperactivity (ADD+H and ADD-H). This disorder thus focused on attention rather than hyperkinesis, and featured problems in three subdomains of attention, impulsivity, and hyperactivity. The introduction of this multi-dimensional perspective was influenced by Douglas et. al, (1983) who argued that inattention, rather than impulsivity and hyperactivity, was the core feature of ADD (Douglas & Parry, 1983; Healey et al., 1993).

The criteria evolved further in the DSM-III-Revised (DSM-III-R (1987)) with a new name of Attention Deficit/Hyperactivity Disorder, with somewhat revised diagnostic criteria. ADHD shifted from distinct symptom dimensions to a unidimensional list of symptoms that included those from the domains of inattention and hyperactivity, but this time highlighted impulsivity (American Psychiatric Association, 1987). Of the five new symptoms introduced to the ADHD diagnosis, four were related to impulsivity (Healey et al., 1993).

Between the DSM-III-R (American Psychiatric Association, 1987) and the DSM-IV (American Psychiatric Association, 1994) the criteria for diagnosis once again changed, and has largely remained through the publication of the current edition, the DSM-5 (American Psychiatric Association, 2013). With the DSM-IV came the introduction of formal subtypes based on factor analysis, including an inattentive subtype (allowing for diagnosis without meeting the clinical threshold for hyperactivity but now formally defined, unlike the informal note in DSM-III for ADD without hyperactivity), hyperactive subtype (fails to meet full criteria for inattention), or combined subtype (hyperactivity and inattention both exceed threshold).

Of note, the symptoms for impulsivity were reduced to those largely related to verbal and internal impulsivity (often interrupts and intrudes on others, has difficulty waiting their turn, often blurts out answers before questions are completed), with the DSM-IV removing physical

and external impulsivity (i.e., “often engages in physically dangerous activities without considering the consequences”). The narrower interpretation of impulsivity remains through the DSM-5-Text Revision (DSM-5-TR) (American Psychiatric Association, 2022).

Three significant changes are noteworthy in the transition between the DSM-IV and the DSM-5: first, the required age of onset increased, from age 7 to age 12, based on analyses showing that late-onset (onset between 7-12) exhibited more severe functional impairment and poorer family support than those who experienced early in life onset (Lin et al., 2015). Second, the class of disorder changed, from *Disorders Usually Diagnosed in Infancy, Childhood, and Adolescence* to *Neurodevelopmental Disorders.* This holds particular significance because Disorders Usually Diagnosed in Infancy, Childhood, and Adolescence once encompassed both developmental disorders and those rooted in negative behaviors, like Oppositional Defiant Disorder and Conduct Disorder. The reclassification of ADHD under Neurodevelopmental Disorders signified a shift in understanding, distinguishing it from behavioral disorders and recognizing it as a neurodevelopmental condition. Third, the descriptors of ADHD profiles moved from “subtype” to “presentation,” better identifying the more fluid nature of ADHD profiles (Epstein & Loren, 2013).

Of additional importance, despite continued convergence from one revision to the next, there are several significant differences between the DSM-5 and the International Classification of Diseases, 11th edition (World Health Organization, 2019), used more frequently outside the United States. Of note for this paper is that the ICD-11 includes additional impulsivity criteria, specifically “a tendency to act in response to immediate stimuli without deliberation or consideration of risks and consequences (e.g., engaging in behaviours [sic] with potential for physical injury; impulsive decisions; reckless driving)” as a symptom for hyperactive/impulsive ADHD (World Health Organization, 2019). For the purposes of this dissertation, I focus on the

DSM formulation rather than the ICD formulation due to the DSM being the criteria upon which all present data were collected—but I critique the limited coverage of impulsivity in DSM-5.

3.1.2. Contemporary ADHD Diagnostic Criteria and Domains

As it stands today, the diagnosis of ADHD in DSM-5 relies on two distinct symptom sets for each presentation: one for inattention, and one for hyperactivity/impulsivity. Meeting criteria for one or both of these symptom sets (as well as other requirements, including age of onset, duration, multiple settings of symptoms, and rule-outs) leads to a diagnosis of ADHD and to a specifier as one of three presentations: ADHD, predominantly inattentive presentation (ADHD-IN), ADHD, predominantly hyperactive/impulsive presentation (ADHD-HI), or ADHD, combined presentation, when one meets full criteria from both symptom sets (ADHD-C).

To meet criteria for ADHD, one has to have experienced or exhibited a "persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development" in two or more settings (i.e., home and school) (American Psychiatric Association, 2013). While ADHD-related impairment frequently persists into adulthood, often causing vocational, relational, and social challenges (Abdelnour et al., 2022; Wender, 1975), a requirement for diagnosis is that one must have displayed several symptoms of the disorder in childhood, specifically before the age of 12. Of additional importance, another requirement for the DSM-5 diagnosis is that the symptoms are not solely a manifestation of oppositional or defiant behavior, a lack of understanding of expectations, or not better explained by another psychiatric or medical condition or drug use. See Appendix I for full diagnostic criteria, as well as the related criteria for ADHD in the ICD-11 (World Health Organization, 2019) which are not discussed here. While the DSM approach has offered numerous benefits for research, including statistical validity and reliability, the current project aims to establish a stronger empirical

connection to the many associated features that are not part of the diagnostic criteria for the benefit of future clinicians and clinical evaluation.

3.2. ADHD Factor Structure

As noted in the prior section, ADHD in the DSM-5 includes two symptom dimensions. Since the publication of DSM-III, there has been much exploration of the statistical factor structure to attempt to best determine both the diagnostic criteria as well as the subtypes/presentations as explored in the DSM (Achenbach et al., 1995; C. K. Conners et al., 1999; Edelbrock et al., 1984; Healey et al., 1993; Lahey et al., 1988). When using the symptom sets adopted by the DSM-III or DSM-IV, Exploratory and Confirmatory Factor Analysis (EFA and CFA) consistently support the distinction (of at least) the two current ADHD dimensions of inattentive and hyperactive (Willcutt et al., 2014).

A persistent question has been whether impulsivity should be a separate dimension of ADHD, or essentially overlapping with hyperactivity. Willcutt, et. al's (2014) review of the validity of the two ADHD symptom dimensions and subtypes (as they were labelled at that time), noted that in studies of a combined 60,000 children and adolescents, inattention and hyperactivity/impulsivity tend to load on separate factors and be distinct from other disorders, save for a strong correlation of hyperactivity-impulsivity with defiance/aggression (or Oppositional Defiant Disorder). Willcutt et al also noted that whether impulsivity should be considered a part of hyperactivity or as a nominal dimension is less clear. Some studies find that a three-factor model with separate impulsivity and hyperactivity factors fit better than a two-factor model. However, the incremental fit improvement is generally minor (Willcutt et al., 2014), perhaps influencing the decision in DSM-IV to retain only two factors. Finally, as Willcutt et al noted, the limited number of impulsivity items in the DSM-IV (which remained for

the DSM-5) renders it difficult to distinguish between hyperactivity and impulsivity as defined there (Willcutt et al., 2014).

Other studies, using a statistical decomposition called a bifactor model, explore whether a general, or G, factor of ADHD explains more of the variance than specific, (S) factors (for inattention and hyperactivity/impulsivity). One study showed that a bifactor model with a strong general factor and two or three weaker specific factors showed superior fit to a traditional bifactor or single factor analysis, without one overriding general factor (Arildskov et al., 2022). In a meta-analysis of 31 bifactor model studies of ADHD, Arias et al. (2018) warn that while the evidence for bifactor models are robust, it is also still a working hypothesis, and there is varying correlation between both S and G factors as well as S factors between themselves that should be explored. They also opined that ADHD is better represented as a complex, multidimensional construct, rather than a single continuum (Arias et al., 2018). Ongoing factor analytic work (DuPaul et al., 2016; Garner et al., 2017; Hardy et al., 2007; Proctor & Prevatt, 2009; Silverman et al., 2022) may yet lead to improved refinement of the dimensional factor space. Broadening the factors under consideration (as discussed later) may inform such work and improve upon it.

3.3. Research Domain Criteria (RDoC), ADHD Dimensionality, and Heterogeneity

As already alluded, the dimensional aspects of ADHD are important. One limitation of the DSM model is that it classifies psychiatric disorders as distinct rather than interrelated (de la Peña et al., 2020). This fails to conform to the empirical reality of heavy co-occurrence as well as individual variation in clinical problems (Fonagy & Luyten, 2018; S. P. Hinshaw, 2018). In addition, by relying on a diagnostic status that relies on symptom lists for inattention and hyperactivity/impulsivity, rather than a dimensional understanding of ADHD, the DSM model may be overly-narrow. This is particularly limiting to those who experience both symptoms of ADHD as well as other symptoms not defined by the DSM-5 ADHD criteria, that still impair

their executive and overall functioning (Hechtman et al., 2011). Integrating related traits and dimensions, as we aimed to do in this project, may enrich the phenotype. This in-turn may lead to both higher levels of conceptual understanding of ADHD presentations as well as broader access to clinical intervention to those who show more heterogeneous presentations of the disorder.

A dimensional approach to child behavior and emotional problems has been historically long standing in the field (Achenbach, 1966; C. K. Conners, 1967). More recently the NIMH proposed a dimensional approach to mental disorders called the Research Domain Criteria (RDoC) (Kozak & Cuthbert, 2016). It emphasizes understanding mental illness in terms of neurobiologically grounded psychological dimensions in lieu of a sole focus on diagnostic categorization. Nigg et al., (2020), note that when examined through the DSM-5, much of ADHD's heterogeneity is ignored. However, when examined through the lens of RDoC, and specifically through the dimensions of cognition (described in RDoC as domains such as cognitive control and working memory) and temperament (encapsulated for example in "positive and negative valence" RDoC domains), heterogeneity in ADHD is more readily described and captured in empirical terms. They suggest the field is close to "justifying an emotionally dysregulated sub profile in ADHD" (Nigg, Karalunas, Feczko, et al., 2020). While full review of RDoC ADHD-related studies is well beyond the scope of this paper, several studies have examined ADHD through the lens of RDoC, focusing on analyzing the structure of ADHD through RDoC constructs as well as noting various forms of heterogeneity in the disorder (See Musser & Raiker (2019) for a review). This study aims, using an RDoC lens, to examine ADHD through development, focusing on the domains of negative valence and regulation to examine heterogeneity in the ADHD population.

Beyond RDoC, relevant dimensions can be thought of both in terms of dimensions of clinical problems as well as in relation to dispositional traits (personality and temperament). I consider each in turn.

3.4. Associated Clinical Dimensions with ADHD: the "ADHD-Five"

With regard to disorders, ADHD has a high rate of comorbidities, including anxiety and depression (Gair et al., 2021), Autism Spectrum Disorder (Hours et al., 2022), Oppositional Defiant Disorder (Molina et al., 2001), and Conduct Disorder (Cuffe et al., 2020), that often have significant and negative impacts on a child's functioning over and above the impacts of ADHD alone. However, with regard to dimensions, ADHD is increasingly seen as clinically associated with other symptom dimensions that are not necessarily attributable to or fully due to other diagnoses, but are part of the syndrome for many children. These associated symptoms have significant impact on behavior, socialization, and activities of daily living. It is important to note that each of these clinical domains discussed in this section also have overlap with other diagnoses, including the aforementioned comorbidities and are not unique to ADHD. The present study aims, however, to explore how selected clinical dimensions relate to ADHD as it is conceptualized in the DSM-5. These are: inattention, hyperactivity, impulsivity (already embedded in DSM-5 of course, but see below), Cognitive Disengagement Syndrome (CDS), and irritability. For the purposes of this paper, CDS is considered a dimension, rather than a syndrome, with a spectrum of behaviors and symptoms detailed later.

The two ADHD dimensions are the two established dimensions within ADHD, inattention (which includes features of and is correlated with disorganization and executive functioning (Magnus et al., 2023)), and hyperactivity (which includes and is correlated with aspects of impulsivity discussed below (American Psychiatric Association, 2022)). Although impulsivity, irritability, and SCT are relevant to other disorders and conditions besides ADHD,

for simplicity, inattention, hyperactivity, impulsivity, CDS, and irritability will be referred to as the "ADHD-5" clinical dimensions for shorthand herein.

3.4.1. Impulsivity

Due to previously mentioned past controversy over the adequacy of representation of impulsivity in the ADHD DSM-5 criteria (Coghill & Seth, 2011), this paper considers a broader spectrum of impulsivity than is currently represented in the current ADHD diagnostic criteria. Impulsivity itself encompasses behavioral concerns beyond merely the impulsive speech and internal restlessness items in the DSM-5 (Coghill & Seth, 2011; Li et al., 2010; Ünsel Bolat et al., 2016; Walerius et al., 2018). For example, impulsivity often encompasses thoughtless and/or risky behavior that is not encompassed in the DSM-5 ADHD criteria (Dekkers et al., 2022). As noted previously, the DSM-III-R included a slightly wider range of impulsivity symptoms than are in the current DSM-5 criteria, and the ICD-11 also slightly expands impulsivity criteria (See Appendix 1 for both DSM-5 and ICD-11 criteria).

Impulsivity has been defined many ways across different literatures. Acknowledging that, Nigg (2017) summarizes impulsivity as generally having two fundamental definitions in the literature. The first is the non-reflective selection of a stimulus-evoked response, which can be considered synonymous with or closely related to *disinhibition.* The second facet is the non-reflective selection or preference for a smaller rewarding response that is immediate rather than a larger but delayed response (Nigg, 2017). For the first, an example would be a child running into the street after a ball without pausing to consider traffic. Important to note, non-reflective stimulus-evoked response can also be habitual and therefore adaptive, i.e., automatically putting on your seatbelt when you sit in a car without consciously having to think about it. However, such behaviors would not be classified as clinical impulsivity. For the second, an example might be a student who committed to waking up early to work, but instead stays up late into the

evening consuming social media even though this defeats their own considered goals. The classic description is of the addict trying to quit, who when unreflectively in taking a drink chooses immediate gratification over the later reward.

As Nigg (2017) notes, this second facet is more than disinhibition, as it reflects the computation, at least implicitly, of the relative weighting of immediate versus delayed reward value or the discounted value of the future reward. As elucidated by Sagvolden (2005) who uses the more precise term 'reinforcement' to described the aforementioned behavior, "the importance of reinforcement in impulsive behavior is supported by the fact that children with ADHD are not always impulsive as they temporarily do manage to plan ahead, organize themselves, and remember important things, if this behavior is maintained by potent and frequent reinforcers (Douglas 1999)."

Other models of impulsivity focus on the multidimensionality of the construct. One key model of impulsivity, reflected in the UPPS-P Impulsive Behavior Scale, was created using factor analysis of commonly used impulsivity measures at the time (Whiteside & Lynam, 2001). The factors revealed were Urgency, (lack of) Premeditation, (lack of) Perseverance, and Sensation Seeking (Whiteside & Lynam, 2001). It has held up well in meta-analyses (Magid & Colder, 2007), although has been less reliable in studies of impulsivity in relation to addiction (Kale et al., 2018). Other studies offered a slightly modified 3-factor hierarchical model of deficits on low conscientiousness, high sensation seeking, and urgency (Watts et al., 2020).

A meta-analysis of 125 studies of numerous questionnaires of impulsivity —mostly featuring undergraduate or community-based populations—investigating the interplay between impulsivity and personality traits, unveiled an alternative three-factor framework of impulsivity resembling Eysenck's seminal models (H. J. Eysenck, 1947). The factors identified were Extraversion/Positive Emotionality, Neuroticism/Negative Emotionality (referred to as Negative

Urgency), and Disinhibition (the opposite pole of Constraint/Conscientiousness) (Sharma et al., 2014). Our research intends to continue this line of inquiry examining the heterogeny of impulsivity.

It is important to note that impulsivity is a general feature of children and in the case of ADHD, the symptom is unusual and excessive impulsivity. Impulsivity is considered clinically significant when it is related to or causative of impairment. However, when examined in trait models, impulsivity is simply a dispositional style. Indeed, impulsivity in childhood or adulthood can be appropriate and adaptive in particular situations, such as when living in a war zone or other situations that require instant decision making (see review and citations in Nigg, 2017). Impulsive behavior by either definition is relevant to psychopathology when it is excessive, maladaptive, or associated with harmful choices. Empirically, in ADHD it is associated with social and peer relational challenges, academic difficulties, conduct issues, and more (Patros et al., 2016). ADHD-related impulsivity is also associated with increased risk for pathological gambling, substance abuse, vehicle accidents, and incarceration (Patros et al., 2016). Adolescents and youth who do not do not experience the typical developmental reduction in impulsivity over time increase their substance use (including alcohol, marijuana, and tobacco) more readily than those whose impulsivity follows the normal decline (Quinn & Harden, 2013).

Particularly in the context of ADHD, it is important to differentiate risk-taking from impulsivity, as they are often conflated, particularly in childhood (Casey, 2015; Nigg, 2017). Both can be formally and mathematically defined. Risk-taking as a behavior mathematically formalized involves mental estimations and computations about probability of punishment or loss. While risk-taking can be impulsive (one can take a risk without pausing to think, such as the aforementioned child running into the street (risk) to get their reward (the ball) without computing the likelihood of punishment (getting injured by a car). However, risk-taking can also

be reflective (taking a leave of absence from a job to work on a personal project that may or may not result in financial success). While the reward of planful risk taking is likely the stimulation or excitement to attain a goal, frequent, excessive, and/or impulsive risk-taking likely is related to both strong reward motivation, as well as suppressed estimation of probability of failure, punishment, or loss (Nigg, 2017).

In contrast, impulsivity's defining characteristic is preference for the temporal: greater weighting of immediate (note: not simply earlier) reward, with a lesser consideration for valence or value of reward or of its probability. Impulsivity is therefore more heavily reliant on considerations of timing rather than probability of reward (Depue & Lenzenweger, 2006; McClure et al., 2004; Nigg, 2017). From a developmental perspective, we also see differing patterns of development between impulsivity and risk taking. Impulsivity shows a consistent pattern of development, declining linearly from childhood to adulthood (Shulman et al., 2016). In contrast, risk-taking shows a non-linear developmental pattern, peaking in adolescence and declining in adulthood (Casey, 2015). In the present study, the principle focus here is on impulsivity due to its greater prominence in ADHD conceptualization, and care was taken to interpret data accordingly.

3.4.2. ADHD and Impulsivity

In the DSM-5 (2013) formulation of ADHD, hyperactivity and impulsivity are a single dimension. But how do impulsivity and hyperactivity relate when impulsivity is considered more broadly?

Using an RDoC perspective, Beauchaine and colleagues (2017) conceptualized an externalizing spectrum in which externalizing disorders including ADHD are observed through a developmental lens. In this model, ADHD begins in preschool, followed by the development of Oppositional Defiant Disorder, Conduct Disorder, substance abuse, and Anti-Social Personality

Disorder in early adulthood. They suggested that vulnerability to any of these externalizing spectrum disorders (ESDs) is conferred by impulsivity as a trait. They define the trait broadly, as immediate reward being preferred over larger delayed reward, actions taken without forethought, consistent failure to plan ahead, and deficient self-control (Beauchaine et al., 2017, p. 347). In this model, trait impulsivity confers liability for hyperactive or combined presentation ADHD in children, as well as vulnerability to all other ESDs. The authors proposed that trait impulsivity is distributed continuously in the population (Zisner & Beauchaine, 2016). Interestingly, the authors conceptualize that hyperactive-impulsive symptoms of ADHD are the "purest behavioral manifestations of trait impulsivity," due to the fact that they usually arise before children experience environmental and social stressors that may trigger other ESDs (Beauchaine et al., 2017).

When impulsivity is operationalized in the laboratory on a reward-delay choice paradigm, effect sizes for ADHD are modest. In a meta-analysis of 27 studies consisting of 4320 children, 2360 of whom had diagnosed ADHD with the remaining 1960 classified as typically developing, the mean effect size of choice-impulsivity between children with ADHD and typically developing children was $d = .47$ (95% CI = .40–.53, $p < .001$), indicating that children with ADHD perform only moderately more impulsively than typically developing children on choice-impulsivity tasks.

In addition, other demographic traits additionally influence the likelihood of developing impulsivity, such as being younger and male (Patros et al., 2016). However, in task-based impulsivity research, impulsivity significantly predicted parent- and teacher- reported ADHD/ODD symptoms, and longitudinally predicted ADHD diagnosis over and above parent- and teacher-reported ADHD symptoms, gender, and parental education level (Pauli-Pott & Becker, 2021). As those with ADHD age, adults with non-remitted ADHD present higher levels

of impulsivity compared to adults with remitted ADHD and controls, while adults with remitted ADHD have shown nearly the same levels of impulsivity as the control group. This leads to the question of whether impulsivity can be considered an endophenotype of ADHD, or simply be considered a component of hyperactivity (Figueiredo et al., 2021).

The present study does not use task-based measures but rather uses ratings based on trait measures. Impulsivity can effectively be measured by questionnaire measures (Beauchaine et al., 2017; Miller et al., 2010) particularly when conceived of more broadly than as reward discounting.

3.4.3. Cognitive Disengagement Syndrome (previously Sluggish Cognitive Tempo)

A still unofficial yet heavily studied symptomatic syndrome called Cognitive Disengagement Syndrome (CDS, previously known as Sluggish Cognitive Tempo (SCT)) is also be explored. CDS is a constellation of symptoms that include difficulty with sustained attention, difficulty with initiation, and global lethargy. It is suspected to be associated with and/or overlapping with ADHD in some cases, yet is also a distinct construct (Barkley, 2016; Burns & Becker, 2021; Willcutt et al., 2014; Yung et al., 2022). One of the most significant difficulties with CDS to date has been in defining it and differentiating it from other diagnoses, especially the inattentive presentation of ADHD. CDS first piqued clinical interest with the advent of the two subtype model of ADD, with and without hyperactivity (ADD+H and ADD-H), found in the DSM-III. At that time, studies found that ADD-H had more symptoms of sluggishness, sleepiness, daydreaming, and social withdrawal compared to ADHD+H children, and found factor analytic support for a “sluggish tempo” factor with separately loaded items from an inattention and disorganized factor reviewed by Becker (Becker et al., 2023).

As reviewed by Becker, between 1988 and 2019, researchers have held continually evolving understanding of the syndrome, and a consistent CDS item set is still in progress across

the field. However, 13 CDS items have been consistently identified in meta-analysis of CDS. These have in turn been found to have internal and external validity in children with and without ADHD, and can be differentiated from self-reported ADHD-Inattention (Becker et al., 2020) (See Appendix II). CDS can globally be considered to include mental confusion, fogginess, lethargy/sleepiness, and excessive day dreaming (Mueller et al., 2014), presumably not explained by sleep disorder or other medical problem.

Symptoms of CDS are not unique to ADHD and have been found to be elevated in children exposed to prenatal alcohol, pediatric traumatic brain injury survivors, and youth with spina biffida. Greater iron deficiency in infancy additionally predicts higher rates of CDS and ADHD symptoms in adolescence (Becker et al., 2023). CDS is also strongly associated with Autism Spectrum Disorder (ASD). In a study of 413 elementary school children, nearly half of children with ASD scored at least 1.5 standard deviations above the typically developing CDS mean (Mayes et al., 2022).

CDS is strongly associated with difficulties in academia and cognitive performance (Baytunca et al., 2018; Fredrick & Becker, 2023b; Mayes et al., 2022). However, findings are mixed regarding the relationship between CDS and processing speed, with several studies showing that there is no association between CDS and slow processing speed as measured by neurocognitive tasks, including Rapid Automized Naming, the Stroop task, and Symbol Digit Coding (which is another significant reason behind the change in nomenclature from Sluggish Cognitive Tempo) (Bauermeister et al., 2012; Baytunca et al., 2018; Becker et al., 2023; Willcutt et al., 2014). Studies that have found significant relationships between CDS and processing speed note a clear association with increased motor demand performance, which may explain the reason between the mixed literature on CDS and the relationship with processing speed (Becker et al., 2020).

CDS is associated with greater social withdrawal (Solanto et al., 2009), less engagement in classroom activities (Fredrick & Becker, 2023b) poorer social skills (Fredrick & Becker, 2023a). Indeed, SCT is significantly linked to social impairment and manifests in ways like shyness and loneliness, although interestingly, it does not seem to be related to actively being excluded or disliked by peers (Becker et al., 2023).

In contrast to impulsivity, CDS is strongly associated with stronger behavioral inhibition (Fox et al., 2005), defined as avoidance and resistance to novel people, objects or situations (Kagan et al., 1984). Behavioral inhibition is also a predecessor for the social withdrawal also frequently seen in CDS (Fredrick & Becker, 2023a). To date, one study has tested the temperamental correlates of CDS in youth. Becker et al. (2013) found parent ratings of the fear/shyness component of the behavioral inhibition system to be uniquely associated with higher CDS symptoms, while they were negatively related to ADHD-IN. This study used three commonly-used items to measure SCT: "confused or seems to be in a fog," "daydreams or gets lost in his/her thoughts," and "stares blankly."

While CDS can be considered a syndrome, it can also be conceptualized as a dimensional trait. Particularly when considering the relationship CDS has with ADHD and particularly ADHD-IN, further exploration of the impact CDS has on various measures of psychopathology and its relationship to temperament is indicated.

3.4.4. ADHD and CDS

Historically, some argued that CDS was simply a subset of DSM ADHD-IN (Capdevila-Brophy et al., 2006; Todd et al., 2004; Watabe et al., 2014), an understandable hypothesis as most studies show them to be very closely related, particularly in children with very low symptoms of hyperactivity (Barkley, 2016; Bauermeister et al., 2012; Baytunca et al., 2018; Becker et al., 2018). However, while CDS is not yet in the DSM, studies have consistently found

that CDS and ADHD are separate but highly related syndromes in adults (Mayes et al., 2023) and in children and adolescents (Barkley, 2013; Becker et al., 2016, 2018; Burns & Becker, 2021; Servera et al., 2018).

Several studies using factor analysis has confirmed that CDS as a symptom dimension is structurally distinct both from the ADHD-IN domain as well as from the ADHD diagnosis (See Becker (2016) for review). Many children with ADHD-IN also have symptoms of CDS, while it is far less common for children with ADHD-HI or ADHD-C (Hartman et al., 2004). Indeed, in a twin study, CDS and ADHD-IN presented as twice as strongly associated genetically than CDS and ADHD-HI when measured by the Child Behavioral Checklist (CBCL, (Achenbach, 1999)) (Mueller et al., 2014). It has been hypothesized that CDS-associated functional challenge are distinct from those associated with ADHD. CDS appears less associated with cognitive function than does ADHD, i.e., in terms of impacts on EF or inhibitory control (Baytunca et al., 2018).

Indeed, due to the relationship CDS has with behavioral inhibition, it is likely that children with CDS show low impulsivity, but this is a key question to explore. Instead, it seems plausible that CDS compromises task performance by slowing down other processes related to the tasks including over-activating inhibitory control, such as tasks measured by the Conners' Continuous Performance Task (Mueller et al., 2014; Solanto et al., 2007).

CDS additionally has been shown to have different responses to medication than in ADHD, with baseline SCT severity the strongest predictor of treatment effect on SCT rather than ADHD symptoms (McBurnett et al., 2017). Age, sex, race, and parent SES (as measured by occupation) appear unrelated to CDS, and both ASD and Insomnia have been showed to be risk factors for CDS (Mayes et al., 2023). Regardless of the mechanisms behind the impact, co-morbid CDS has significant functional impacts over and above ADHD-IN alone. Examining the

relationship CDS symptoms have to ADHD and comorbid trajectories is indicated to increase our understanding of heterogeneous ADHD profiles.

3.4.5. Emotional Dysregulation and Irritability

Emotional Dysregulation (ED) refers to difficulties in inhibiting or regulating the frequency, valence, and time intervals of challenging emotional states, resulting in severe emotional lability (Barkley & Fischer, 2010). ED and ADHD are correlated when ED is measured in numerous ways, such as via ratings of affective lability or deficient emotional self-regulation (Sobanski et al., 2010). Chronic irritability is one of several constructs that fall under the umbrella of ED. While numerous downstream symptoms may be associated with ED in the context of ADHD and its comorbidities, this study primarily focused on irritability itself, although we additionally discuss the relationship of Emotional Dysregulation to ADHD as a whole in the section below. This decision was predicated on the extensive and robust body of research examining the relationship between irritability and ADHD.

Irritability is an emotional domain that often manifests in children with ADHD and other disruptive behavior problems as frequent angry outbursts, short temper, impatience, low frustration tolerance, and moodiness (Nigg, Karalunas, Gustafsson, et al., 2020; Blanken et al., 2021; Colonna et al., 2022; Fernández de la Cruz et al., 2015; Shaw et al., 2014; Wakschlag et al., 2015). Irritability is also unofficial and is not a dimension of ADHD recognized in the DSM-5, but the relationship is being heavily studied in the literature (Nigg, Karalunas, Gustafsson, et al., 2020; Baytunca et al., 2018; Becker et al., 2020; Becker & Willcutt, 2019; Garner et al., 2017; Hartman et al., 2004; Willcutt et al., 2014).

Irritability can be described as “a propensity to react with anger, grouchiness, or tantrums disproportionate to the situation” (Stringaris & Goodman, 2009a). With regard to trait response, a central mechanism is thought to be frustrative non-reward (Leibenluft & Kircanski, 2021),

defined as the removal of, or impediment to obtaining, a previously available or expected reward (Gatzke-Kopp et al., 2015). This hypothesis connects it conceptually to Approach, Extraversion, and Positive Emotionality (strong reward attraction) according to some models of those traits. Irritable emotions are associated with physiological, experiential, and behavioral findings, including increased heart rate, feeling of anger, and urge to fight, presumably as a way of achieving one's goals.

Karalunas and colleagues (2014), using a community detection algorithm with temperament traits as features, observed 3 types or profiles of ADHD, labelled mild (with unremarkable emotional regulation), surgent (with high levels of approach and motivation), and irritable (Karalunas et al., 2018), highlighting the potential importance of ED to the ADHD phenotype. Nigg (2020) found evidence that genetic risk load for ADHD is shared with irritability, supporting a view that it is a core component of ADHD for many children. Irritability presents in 57-92% of children with ADHD (Colonna et al., 2022) and between 34-70% of adults with ADHD (Shaw et al., 2014). Irritability is associated with higher impairment, poorer outcomes, and higher rates of comorbidity that are independent of the effects of said comorbidities (Colonna et al., 2022).

3.4.6. ADHD, Irritability and Emotional Dysregulation

While there has been a renaissance in research implicating irritability and/or ED as a core component of ADHD (Barkley & Fischer, 2010), this is not an entirely new theoretical construct. As noted by Yue and colleagues, prior to the advent of the DSM-III (between 1902 and 1981) depictions of ADHD and ED were closely linked, with Sir George Still describing a core feature of the ADHD precursor as 'excessive emotionality' (Yue et al., 2022). According to Yue et al., in the early conceptualization of ADHD as 'minimal brain damage,' ED was considered to be more important than inattention among the core symptoms. Irritability is significantly related to

depression (and indeed, is considered a qualifying symptom of it, along with sadness or tearfulness (American Psychiatric Association, 2022)). Questions remain as to which of ADHD or persistent irritability contributes to risk of later depression more significantly (Eyre et al., 2019).

Irritability is also the defining core of Disruptive Mood Dysregulation Disorder (DMDD) and is a feature of Bipolar Disorder (Leibenluft, 2011). In DMDD, irritability is conceptualized as containing phasic (severe and developmentally inappropriate) and tonic (persistent irritable mood between outbursts) features (Cardinale et al., 2021). Only phasic irritability has a significant association with ADHD symptoms, indicating that phasic and tonic irritability might actually be distinct domains (Cardinale et al., 2021).

Indeed, recent studies have shown high negative affect, especially in the form of irritability, as an important developmental precursor of ADHD symptoms, as well as a potential core feature of the disorder in some children (Karalunas et al., 2021; Nigg, Karalunas, Gustafsson, et al., 2020). Yue and colleagues (2022) proposed a similar model to that of Karalunas et al and Nigg et al., suggesting ADHD-simplex (ADHD alone) vs ADHD-complex (ADHD + ED). Yue's recent factor analysis shows support for poor emotional regulation skills and irritability aligning with other ADHD components, and those with ED often show higher and more severe ADHD symptoms as well as higher correlation with risk of comorbidities including ODD, Anxiety, and Mood disorders (Yue et al., 2022). Longitudinally, ADHD has been predictive of higher symptoms of irritability two years later (McKay et al., 2024).

Irritability follows differing trajectories for males versus females, with irritability declining in adolescence in males but staying more stable in females (Caprara et al., 2007; Riglin et al., 2017). Kahle et al. (2021) found that irritability predicts hyperactive and impulsive symptoms in adolescents for females, but not males, as well as higher levels of baseline

irritability predicting hyperactive and impulsive symptoms 18 months later in females, but not males. In addition, higher irritability has more often been found in ADHD-C than in the ADHD-IN only, which indicates the possibility of a specific link between hyperactivity, impulsivity, and irritability in ADHD (Mayes et al., 2019). However, this may be attributable to the fact that ADHD-C, by definition, is a more severe presentation than ADHD-IN so is likely to be globally associated with more negative co-morbid symptoms.

Irritability may also be an indicator of the efficacy of treatment. While existing behavioral treatments appear to have relatively little impact on the core ADHD symptoms of inattention and hyperactivity, behavioral treatments targeted at improving emotional regulation in young children with ADHD may also improve their ADHD symptoms (Karalunas et al., 2021), though contradicting results have also been seen (Stuckelman et al., 2017). In addition, emotional dysregulation predicted the effects of stimulant medication on ADHD symptoms over and above initial ADHD severity over a one-year interval (Blanken et al., 2021). In short, any attempt to evaluate an enriched ADHD phenotype with an RDOC lens appears well advised to include irritability in some form.

3.5. Traits and ADHD: Temperament, Personality, and ADHD

3.5.1. Temperament and Personality Traits and Models especially relevant to ADHD

The conceptual relationship of psychopathology to dispositional, temperament, and personality traits has a venerable history (Eisenberg et al., 1996; H. J. Eysenck, 1947; S. B. G. Eysenck & Eysenck, 1977; Gray, 1991; Rothbart, 2007). Much contemporary trait research into this relationship has grown out of derivations of HJ Eysenk's foundational personality theory. This theory postulated that biological predisposition, in tandem with environmental influence, cultivated differing dimensions of personality that in turn influenced the development of and

resilience to psychiatric difficulties (H. J. Eysenck, 1947). Further historic models of personality are described later.

This conceptual relationship is still being examined and expanded to integrate epigenetic considerations. As described by Lahey (2024), rather than assuming psychological problems are each unique, disparate processes, a powerful alternative is to rely on an integrated model that includes both psychological problems and dispositions. Lahey recommends that instead of attempting to identify the mechanistic causes underlying every dimension of psychological problems, it would be far more feasible to identify the causes and mechanisms underlying the few, but important, personality traits that correlate with psychological problems as foci for understanding psychopathology, examining etiology, formulations and devising new treatments. In his paper, Lahey strongly argues for the importance of investigating and integrating the study of traits into psychopathology research, which this study aimed to implement.

When it comes to ADHD in particular, certain dispositional traits, particularly those that are inherent in or related to emotional regulation, have been shown to be strongly related to ADHD etiology (Nigg, Sibley, Thapar, et al., 2020), presentations (Karalunas et al., 2018), and outcomes (Blanken et al., 2021; Emilsson et al., 2020; Krieger et al., 2020). For an in-depth examination of the relationship of ADHD with temperament traits, see (Nigg, 2022). The present study aims to further this venerable tradition of research with a selective consideration of traits described below. I begin by considering temperament and personality then returning to emotional dysregulation.

Despite historical distinctions between temperament (in children), personality (in adults), and disposition (lifespan), empirically the traits studied can be referred to as temperament or personality; herein, “traits” will refer to either domain. Conceptual distinctions are important for some developmental questions, particularly the consideration that temperament traits do not

include specific thoughts, cognitions, or concepts about self or others, while personality traits do (Rothbart, 2011). However, empirical work supports a close relationship between major traits of childhood (often called temperament) and corresponding traits in adulthood (typically called personality) (Buss et al., 2019; Caspi & Shiner, 2008; Rothbart, 2007, 2011; Shiner, 2021). Although personality and temperament approaches extend beyond the trait perspective (McAdams et al., 2019; Rothbart, 2011), the trait perspective has been productive in clinical science, offers ready portability to clinic use when appropriate, and therefore is the approach pursued here.

That said, a range of trait models can be considered, including the personality Big Five (John et al., 2012), (or alternative Six in some models (K. Lee & Ashton, 2018)), These models are increasingly validated in adolescence ((Borghuis et al., 2017; Jones et al., 2022; Zhou et al., 2017), as well as in other child personality and temperament trait models (Meier et al., 2022; Meier & Zimmermann, 2018). Although many temperament and personality trait models exist, with a focus on ADHD as involving self-regulation, the present study emphasizes key regulatory trait features from two major trait models. These traits are Ego-Resiliency and Ego-Undercontrol (Block & Block, 1982), as well as Behavioral Regulation and Emotionality (Eisenberg et al., 1996).

While the ADHD-5 clinical features are of interest as summarized above, they are also of interest in reference to their relationship with dispositional traits and how those traits impact the development and trajectories of the ADHD-5. While most personality research historically has been done with children ages 10 and above, recent advances in evaluation of childhood personality (Slobodskaya & Kornienko, 2021; Wright & Jackson, 2022) makes the inclusion of such traits in the study of developmental psychopathology all the more timely. Specifically, this research built on work that has specifically examined the intersection of ADHD comparatively

with developing personality/temperament trait features in childhood and adolescence (Bouvard et al., 2012; Gomez & Corr, 2014; Hai & Climie, 2022; Krieger et al., 2020; Martel, 2009a; Martel et al., 2022). This previous work has revealed interesting findings that vary depending on whether ADHD is looked at as one global diagnosis, rather than by subtype or by its constituent symptom domains, further indicating the importance of expanding phenotypic understanding of the differing presentations of the disorder. With the rich history of temperament research over the past century, the present study relies on a handful of modern models.

Block and Block model. Self-regulatory traits relevant to problems like ADHD are richly reflected in the classic developmental model of personality proposed over a generation ago by Block and Block (Block & Block, 1982). The two super-ordinate traits in this model are Ego-Resiliency and Ego-Control. Block and Block's model is highly influenced by Lewinian theory, particularly the theory of boundaries, permeability, and elasticity (Lewin, 1935). The Blocks' model has had utility in describing characteristics related to clinical risk, including drug use, in adolescents (Liu et al., 2021; Shedler & Block, 1990).

Ego-Control. Ego-Control is defined by Block and Block as an individual's tendency for impulse control and modulation. Ego-Undercontrol postulates a high level of impulsiveness and expressivity and Overcontrol indicates overly restricted behavior and self-expression. Ego-Undercontrol is considered to reflect excessive boundary permeability, inability to delay gratification, and vulnerability to environmental distractors. Overcontrol, in contrast, is conceptualized as high levels of control and a need for strong levels of order and consistency. Optimal adjustment is theorized to lie not at the extremes but in the middle range of control. As the Block's write, "Extreme placement on either end of Ego-Control implies a constancy in mode of behavior that, given a varying world, can be expected to be adaptively dysfunctional" (Block & Block, 1982). They note that when investigated in adults in their mid-30s, adults who

are high in overcontrol tend to come from families that emphasized structure, order, and conversative values, while those who are undercontrolled are more likely to come from homes that had high degrees of conflict, discrepant values, and lower emphasis on socialization (Block & Block, 1982).

Ego-Resiliency. Ego-Resiliency is conceptualized as a person's ability to adapt and manage their level of control to the context; thus, high resiliency is considered most adaptive. Ego-Resiliency is related to Lewin's theory of elasticity, or "the capacity of a boundary to change its characteristic level of permeability-impermeability depending upon impinging psychological forces and return to original level of permeability after temporary, accommodation-requiring influence is no longer pressing" (Block & Block, 1982). In other words, Ego-Resiliency is not only an indicator of adaptability but also boundary stability. When one no longer has significant need to adapt, Ego-Resiliency describes the ease with which they return to emotional homeostasis. In contrast to Ego-Control, which is idealized at a midpoint between two negative extremes, Ego-Resiliency is measured on a linear scale. Higher levels of resiliency are associated with resourcefulness, flexibility, and the ability to understand and respond to situational demands effectively. Conversely, low Ego-Resiliency, or "Ego-Brittleness," is characterized by a lack of adaptive and social attributes, such as inflexibility, difficulty responding to changing requirements, and disorganized thought patterns, particularly under stress (Block & Block, 1982) Eisenberg (1996) describes Ego-Resiliency as reflecting the capacity for effective coping.

The Relationship between Ego-Resiliency and Ego-Control is such that when Ego-Control is held as constant, Ego-Resiliency provides resourcefulness, open-mindedness and creativity even before a stressful or novel experience presents itself. When novel or stressful experiences do present, Ego-Resiliency allows more easeful processing of stimuli. Ego-

Brittleness will enhance the Ego-Control qualities, with an Ego-Brittle person with Ego-Undercontrol showing impulsivity, restlessness, and emotional dysregulation, and an Ego-Brittle person with Ego-Overcontrol experiencing anxiety, over inhibition, withdrawal, and rigidity (Block, 1982). See Appendix III for a table highlighting qualities of those with different combinations of Ego-Resiliency and Ego-Control. Important to note, these constructs do not exist in a vacuum. There is a conceptual and empirical relationship between the Big Two of personality (Extraversion and Neuroticism) and the Big Two of Block & Block (Ego-Control and resiliency) as well as with the temperament features of negative emotionality (like neuroticism) and positive emotionality (like extraversion/impulsivity) (Huey Jr. & Weisz, 1997).

Rothbart model. Rothbart (2011) conceptualized temperament as hierarchically organized traits and as having three superordinate factors: Surgency, Negative Affectivity, and Effortful Control. Surgency is defined as a child's likelihood to approach novel stimuli, be impulsive, highly active, seek out and experience high-intensity pleasure (related to sensation seeking), and is negatively related to shyness—instead, it connotes social confidence and is related to social dominance and to the personality trait of extraversion. Negative Affectivity, as it sounds, is a child's tendency to exhibit fearfulness, anger, worry, frustration, and sadness. These qualities can be state-like, but also can be seen as traits. Rothbart notes that infant anger/frustration at 6-10 months predicts anger and frustration at age 7, and is additionally predictive of other negative emotions, including anger, discomfort, guilt, shame, and low soothability (Rothbart, 2011). Negative Affectivity conceptually relates to irritability. Effortful Control entails qualities like inhibition, attentional focusing, and perception and is conceptually connected to ADHD-IN, ADHD-HI, and impulsivity. Children high in Effortful Control tend to be low in negative emotionality (Rothbart & Sheese, 2007) so there is a conceptual negative relationship between Effortful Control and irritability, as well. Importantly, Rothbart's model

conceptualizes a dynamic interaction between reactivity (both negative and positive affectivity) and regulation (effortful control), emphasizing their mutual influence on temperament.

Eisenberg et al. model. The Blocks' model was expanded somewhat by Eisenberg and colleagues with her related but distinct concepts of Behavioral Regulation and Emotionality (Eisenberg et al., 1996), which was heavily influenced by a social functionality perspective.

Emotionality. Eisenberg and colleagues describe Emotionality as reactivity to situations likely to produce responses of either positive or negative valence (Eisenberg et al., 1996). It is very similar to individual reactivity in temperament literature. Eisenberg and Fabes predicted that externalizing behaviors, such as aggression and antisocial behaviors, were associated with low levels of regulation. Specifically, they hypothesized that in situations with high stress or valence, individual differences in emotional reactivity would influence the degree and quality of response to the situation (Eisenberg & Fabes, 1992). Eisenberg also hypothesizes that this emotional regulation is based in several mechanisms that rely on attentional control, including shifting attention away from negative or arousing stimuli and the ability to focus on positive stimuli. She notes that coping can be considered a type of emotional regulation, as it's defined as "changing cognitive and behavioral efforts to manage specific external or internal demands that are appraised as taxing or exceeding the resources of the individual (Eisenberg et al., 1996; Lazarus & Folkman, 1984). For this study, we focus on Negative Emotionality due it's conceptual relationship to irritability.

Behavioral Regulation. Eisenberg describes Behavioral Regulation as the external response to outside stimuli, and includes emotion but also other forms of regulation. It is defined as the degree to which one can modulate their physical and physiological responses to various stimuli (and thus is closely related to Ego-Resiliency). It is notably similar to the Block's concept of Ego-Control (1982) but is more focused on the regulation of physical, externalized behavior

(Eisenberg et al., 2000). Low Behavioral regulation is associated with challenges in socialization, problem behavior, and externalizing disorders (Eisenberg et al., 2000). Eisenberg further developed more nuanced theory of emotionally-derived behavioral regulation into "Effortful Control" (the ability to voluntarily focus or shift attention as needed in a given situation) as well as "Reactive Control", defined as "an automatic, 'bottom-up' modulation of behavior in response to immediate incentive (Eisenberg & Spinrad, 2004; Martel et al., 2008).

Eisenberg's scale for this paper is considered a measure of reactive control due to the fact that reactive control is considered trait-like, rather than state-like. These model has been productive in describing risk and resilience in children including some relation to clinical problems (Eisenberg et al., 1996; Favini et al., 2023; Hernández et al., 2023). The connections between Block & Block's and Eisenberg's models have been underexplored, particularly concerning children with ADHD.

3.5.2. Self-Regulatory Traits and ADHD

Remarkably little contemporary research has examined the relationship between Block and Block's Ego-Resiliency and Ego-Control with ADHD, which leaves opportunity for this paper to examine the relationship between these classic trait models utilizing contemporary models of ADHD. Martel (2008, 2009, 2012; 2006) has a body of research into the relationship between these aforementioned behavioral regulation model of Eisenberg and colleagues with ADHD. Her groups' work validates effortful and reactive processes with other personality/temperament traits, revealing that behavioral regulation (for these purposes, synonymous with reactive control) is strongly and negatively associated with hyperactivity, while resiliency and high behavioral control is strongly and negatively associated with inattention in both preschoolers (Martel et al., 2012) and adolescents (Martel et al., 2008, 2011). Martel and colleagues also found that reactive control mediated the pathway between family risk

and substance abuse, which in turn are likely heavily influenced by childhood “behavioral problems” such as ADHD (as seen in the previous study, a lack of behavioral regulation is highly associated with hyperactivity) (Martel et al., 2009). As conceptualized and measured by Eisenberg, there has also been little research conducted on Emotionality and ADHD, which this paper additionally explores.

3.6. Significance of the present study and rationale summary

The overall aim of this study is to enrich our understanding of the componential structure of ADHD by expanding the relevant domains of interest via selected clinical and trait features. A brief recap of the value of this includes the following.

As evidence by the above, the DSM-5, while valuable for research and ensuring statistical validity, has notable limitations when it comes to providing a rich and nuanced clinical assessment that incorporate related, but not diagnostic, traits and domains to various types of psychopathology. To address these shortcomings, it is crucial to empirically integrate closely related traits and features, thereby refining our understanding of phenotypes and enhancing clinical assessment and formulation. This approach aligns with the growing consensus in the field, supported by influential perspectives such as Lahey's work (Lahey, 2024) and the RDOC framework (Kozak & Cuthbert, 2016), which advocate for a trait-based perspective on psychopathology. Applying this perspective to ADHD, the current project seeks to offer a more comprehensive and empirically grounded assessment strategy.

Herein, dimensional heterogeneity or multi-componentiality is mapped by incorporating dimensionally nuanced, transdiagnostic, clinical features referred to as the ADHD-5: inattention, hyperactivity, impulsivity, irritability, and cognitive disengagement syndrome (CDS). These are combined with four non-orthogonal personality or temperament traits (referred to as the Four Traits) selected to enrich the understanding of ADHD as altered self-regulation: Ego-resilience

(Block & Block, 1982), Ego-Undercontrol (Block & Block, 1982), Behavioral regulation (Eisenberg et al., 1996), and Emotionality (Eisenberg et al., 1996). The inclusion of these traits allowed for the examination of positive and negative valence as defined by NIMH's priority RDoC initiative (Kozak & Cuthbert, 2016) and explored their relationships to heterogenous presentations of ADHD and is congruent with Lahey's (2024) call for more attention to dispositions.

This study adds information to the literature in several ways. First, it specifically addresses NIMH strategic priorities regarding dimensional trait measurement (RDoC) in relation to development of psychopathology and identifies critical features during an extended period of development (ages 7/8 to 17/18). Whereas irritability, impulsivity, and CDS are widely studied separately, integrated study of them together in the same study is unusual. Therefore, studying these, particularly using equivalent and theoretically strong measurement (via the expert prototype/Q-sort method described below), is innovative.

Second, exploration of ADHD phenotypes through childhood regulatory traits is extended here with new application, providing novel insights into the multi-dimensionality of ADHD. It also opens the door to deeper theoretical analysis of the syndrome due to the rich theoretical basis of these traits.

Third, although traits have been explored in select and specific contexts in relation to ADHD (Bouvard et al., 2012; Karalunas & Nigg, 2020; Martel & Nigg, 2006), the potential incorporation of the Four Traits with the target clinical domains in the ADHD-5 should provide a novel trait-clinical picture of ADHD profiles.

Methodologically, the study acknowledges and embraces two key methodological challenges to resolving ADHD heterogeneity for clinical application. These are (a) construct definition for clinical features, and (b) measurement variation across traits and dimensions. Both

of these challenges are directly addressed by the use of Q-Sort methodology (described in detail below in the methods section) that brings both uniformity of measurement and expert-created consensus of construct definition. By using the Q-Sort as the single measurement tool for experts to identify the constructs, or prototypes, of the ADHD-5, as well as extant Q-Sort prototypes and scales of the Four Traits, we ensured both consistency of construct as well as uniformity of measurement for analysis. Further, the use of Q-Sort methodology in this context is somewhat novel and the prototypes scales to be developed are new and should bring new tools for research and possible clinical use. The use of Q-Sort methodology and the development of new prototypes could serve as valuable tools for future research and clinical application in the field of ADHD research. One advantage of using Q-Sort methodology is that it enables experts to organize ADHD-traits based on their theoretical and clinical knowledge, rather than being guided by either raw data or exclusively DSM-5 characteristics. Additionally, it generates a score that follows a normal distribution, which contrasts with the ADHD symptom list.

3.7. Specific Aims

Specific Aim 1: Map the conceptual (prototype) relationship cross-sectionally among the ADHD-5 using the correlation among Q-sort prototypes, as well as the association with existing measures of the domains and traits, as explained in Methods.

Hypothesis 1A: strong relationships would be observed cross-sectionally between:

1A.1: Inattention and SCT/CDS as dimensional measures (Becker et al., 2016).

1A.2: Irritability and impulsivity (as a global total score) (Junghänel et al., 2022; Kahle et al., 2021).

1A.3: High SCT/CDS on the one hand and low hyperactivity and low impulsivity on the other (Mueller et al., 2014).

Hypothesis 1B: Regarding the interrelation between the ADHD-5 and the Four Traits:

1B.1: High impulsivity would relate strongly to low Behavioral Regulation and high Emotionality (Eisenberg et al., 1996).

1B.2: SCT/CDS would relate strongly to high Behavioral Regulation (Kofler et al., 2019).

1B.3: High irritability would correlate with low Ego-Resilience, as adaptability to the environment is a hallmark of Ego-Resilience.

1B.4 High irritability would correlate with high Emotionality.

Specific Aim 2A: Map the ADHD-5's relation the four traits using factor structure and exploratory factor analysis to determine cross-sectional relationships between revealed factors and **Aim 2B:** key ADHD-associated psychopathologies.

Hypothesis 2A: The ADHD-5 and the four traits would converge into three higher-order factors that are related to, but distinct from, the two factors comprising ADHD in DSM-5.

Hypothesis 2B: Cross-sectionally, revealed factors would have unique and significant relationships to ADHD and key ADHD-associated psychopathologies; namely Oppositional Defiant Disorder, Conduct Disorder, Depressive Disorders, and Anxiety Disorders. We predicted that factors would explain significantly incremental variance in these associations over and above the ADHD symptom dimensions alone (See Nigg et al, 2023).

Specific Aim 3: Evaluate the clinical utility of baseline factor scores for the factors identified in Aim 2 in predicting longitudinal outcomes and symptom change.

Hypothesis 3: Factors scores at baseline from Aim 2 would predict over and above existing ADHD measures and baseline comorbidity or impairment for: (a) future ADHD symptom trajectory slope, and (b) development of one or more of psychiatric disorders between baseline and completion of studies. Should this hypothesis prove to be correct, we would test relationships individually with several outcome variables, including developing an Anxiety

disorder, developing a Mood disorder, developing a Disruptive disorder, or developing any combination of the previously mentioned disorders over time. We also predict relationships with (c) total Marijuana Usage over time, total Alcohol usage over time, and (d) and dimensional Suicidal Ideation, the prior two due to their uniquely negative impacts on socialization and health outcomes (Cuffe et al., 2020; Mochrie et al., 2020; Patel et al., 2018).

4. Methods

4.1. Participants

Parents of 844 children, ranging in age from 7 to 13 at baseline (92% ages 11 and under), were recruited as volunteers from the local and regional urban and rural community (N = 145 sibling sets, which were statistically analyzed separately, described below in Methods), resulting in a total of 844 children. The sample, the Oregon-ADHD-1000, has been previously reported on in several studies addressing different research questions (Nigg et al., 2023). Participants in the present study were 81% non-Hispanic white, which aligns with the catchment area census data (U.S. Census Bureau, 2019).

4.1.1. Initial Recruitment

To avoid creating artifactual associations (e.g., Berkson's bias) families were recruited from the community. ADHD cases were deliberately oversampled to create a community-recruited case-control sample. Recruitment involved mass mailings to parents of school-age children and public advertisements. Volunteers were screened by phone for eligibility and interest. Human subject approval was obtained from the Oregon Health & Science University Institutional Review Board and appropriate written consent from parents and older children and verbal assent from young children were obtained.

4.1.2. Multi-Stage Screening Process

After phone screening, parents/legal guardians provided consent, and children provided assent. An in-person clinical evaluation was conducted, including standardized rating scales from parents (ADHD Rating Scale, Conners, SDQ) and teachers (ADHD Rating Scale, SDQ), a structured clinical interview by a trained, masters-degree level clinician (KSADS-E), IQ screen (WISC-IV 3 subtests), child mood ratings (Child Depression Inventory, Multidimensional Anxiety Scale), and behavioral observation by staff (K. C. Conners, 2008; DuPaul et al., 1998;

Fraccaro et al., 2015; Goodman, 2001; Kaufman et al., 2000; Kovacs, 1985; Wechsler, 2003). At that stage, best estimate research diagnoses were established by a team of experienced clinicians (a board-certified child psychiatrist and licensed clinical child psychologist) who independently arrived at diagnosis using all available clinical information; their agreement for ADHD and ODD was acceptable ($k > .8$). Disagreements were resolved by consensus discussion. Eligible children were then invited for further studies including the parent Q-Sort.

4.1.3. Exclusion Criteria

Exclusion criteria at baseline included non-stimulant psychotropic medications, history of seizures or head injury, parent-teacher rating discrepancies, intellectual disability (IQ < 75), and certain medical conditions. Further details are available in (Nigg et al., 2023).

Using these procedures, 508 children were classified as ADHD and 301 children as typically developing, non-ADHD at baseline. An additional 35 were considered either subthreshold or a rule-out for an ADHD diagnosis. Of the ADHD group, 133 (15.7%) were classified as being Predominantly Inattentive presentation, 13 (1.5%) as Predominantly Hyperactive/Impulsive presentation, and 362 (42.8%) as Combined presentation. 97 children were identified as having ODD at baseline, all but six in the ADHD group. At baseline, 22.8% of the total cohort was prescribed stimulant medication to manage ADHD symptoms. Participants were followed from baseline for thirteen years. All measures were collected at each time point.

4.2. ADHD and ODD Dimensional scores, Final Variables, and Data Reduction

Child ADHD and ODD. Depending on the predictor variable and research question, we used different ADHD and ODD measures to ensure uniformity of measurement method among co-variates. Most analyses used dimensional scores for ADHD and ODD, based on evidence they can exist as dimension in the population (Evans et al., 2020). For those analyses, we used a previously validated parent-rated child ADHD factor score; indicators were ADHD-Rating Scale

(RS) inattention and hyperactivity-impulsivity raw scores (DuPaul et al., 1998), Kidde Schedule of Affective Disorders (K-SADS) symptoms (Kaufman et al., 2000), Conners-3 hyperactivity and inattentive scale raw scores (K. C. Conners, 2008), and Strengths and Difficulties Questionnaire (SDQ) (Goodman, 2001) (For more on validation procedures, see (Nigg, Karalunas, Gustafsson, et al., 2020)). For those same analysis, ODD was measured via the parent K-SADS symptom count. To ensure robustness of cross-sectional analysis, we additionally analyzed using best-estimate diagnostic team ADHD status when predicting ADHD and ODD outcomes to ensure consistency across conditions. For longitudinal analysis, we used a variable measuring symptom trajectory over the course of the study based on the ADHD-RS, co-varied with the baseline of that trajectory, detailed below in Measures.

4.3. Measures

Child sex assigned at birth, race and ethnicity, age, and parent income as a proxy for Socioeconomic Status were evaluated as covariates in sensitivity analyses.

Creation of new Q-sort prototype scores for all aims using the Q-Sort. The Q-Sort is a well-regarded but under-utilized measurement tool that allows individuals to sort items ranging from most like to least like the item in question, which in this case would be prototypes for the constructs discussed earlier (Block, 1961). This study used Q-Sort methodology to create expert prototypes for various constructs related to ADHD, which in turn brought uniformity of measurement and expert consensus in construct definition and addresses methodological challenges in studying ADHD heterogeneity. This study used the California Child Q-Sort (see below).

California Child Q-Sort. At each in-person visit, the attending parent completed the California Child Q-Sort (CCQ), a common language version of this personality inventory for use by non-professionals developed by Block and colleagues (Caspi et al., 1992). The CCQ involves

sorting 100 cards into nine predetermined categories, reflecting varying degrees of descriptive accuracy from 1 (least descriptive) to 9 (most descriptive), to characterize the child. Instructional guidelines were adapted from the standard instructions developed by Block (personal communication to J Nigg, 1996).

Expert Raters. Experts in each of the constructs of ADHD-Inattention, ADHD-Hyperactive/Impulsive, Impulsivity, Irritability, and SCT/CDS (N=2-3 per construct) were invited to participate in the study. An Expert was classified as such if they have each of the following: A PhD in Clinical Psychology or an MD with certification in psychiatry, scholarly record of publication and expertise on the construct, and clinical training and experience. To make the process more feasible, a computerized Q-sort (Lutfallah & Buchanan, 2019) was sent out to the experts allowing remote participation and more time efficiency.

Procedures for prototype and trait score creation. This process had three elements.

(1) Invitation to experts. Experts in the field who meet the criteria listed above were invited to participate in the proposed study for the purposes of prototyping. They were provided with a secure, computerized California Q-Sort (CCQ) (Block & Block, 1997) using the 100-item, common-language statements (Caspi et al., 1992) to align with previously collected data. Ratings were completed by 7 different experts (N=2-3 per construct) with the instructions to "complete the Q-Sort as if you were sorting for a child who most clearly embodies the qualities of [domain] and is not taking any medications to manage related symptoms if relevant. Please consider the temperament, behaviors, and sociability of this imagined child when sorting." These sorts were then averaged to create a new Expert-Prototype for each construct based on the full 100 items. Compensation was offered via mentor discretionary funds.

(2) Creating Prototype and Behavioral Trait Scores for Participants. Using R (R Core Team, 2020) and the tidyverse library (Wickham et al., 2019), an individual correlation score (-1

to +1) was readily computed for each participant. Using original Block & Block CCQ prototypes of Ego-Resilience and Ego-Undercontrol which were available in the Oregon ADHD-1000 (J. Block & A. Kremen, personal communication, October 1, 1996) we created individual scores for each child for these traits as described above. Eisenberg's CCQ scales for Behavioral Regulation and Emotionality (Eisenberg et al., 1996) scripts were already available in the Nigg lab as well and were used in analysis.

(3) Individual Score Creation. To create the individual scores, the data matrix was inverted so that each child became a column, and each prototype was also a column (i.e., became another "subject" as the prototypical child), and each item in the sort by the parent, or in the prototype, becomes a row in the matrix. Then these scores were entered into a traditional data matrix with children as rows and variables as columns. See **Figure 1** for a visual guide to this process.

4.3.1. Aim-Specific Measures

Aim 1. We used the expert-derived novel Q-Sort prototypes, as well as the extant Block & Block prototypes and Eisenberg's Ego-Resiliency and Ego-Undercontrol scales, all based on the CCQ Q-Sort.

To determine novel prototype's relationships to existing measures of both ADHD-subtypes, we used a previously validated factor score derived from the ADHD-RS, SWAN, SDQ, and Kiddie Schedule for Affective Disorders and Schizophrenia (Brites et al., 2015; K. C. Conners, 2008; DuPaul et al., 1998; Goodman, 2001; Nigg et al., 2023). To determine the relationship the Impulsivity prototype had to existing measures of impulsivity, we correlated the prototype with the Temperament in Middle Childhood Questionnaire (TMCQ) Impulsivity and Inhibitory Control Scales (with the expectation of an inverse relationship to the latter.) To determine the relationship the SCT/CDS prototype has to existing measures of CDS, we compared it to the ADHD-RS' 4 sluggishness items as a mean (DuPaul et al., 1998) as well as

the theoretically related TMCQ Activity Level, Attentional Focusing, and Inhibitory Control scales. To determine the relationship the Irritability prototype had with existing measures, we used the TMCQ Negative Affect scale (Simonds & Rothbart, 2004).

Aim 2A. For the exploratory factor analysis models, variables were (a) the individual prototype scores associated with the expert-derived novel Q-Sort prototypes, (b) the historical extant Block & Block prototypes for Ego-Resiliency and Ego-Undercontrol as well as Eisenberg's Behavior Regulation and Negative Emotionality scales, all based on the Q-Sort.

Aim 2B. We used the revealed factors as well as baseline diagnostic status of ADHD, Oppositional Defiant Disorder, Conduct Disorder, a Depressive Disorder, and an Anxiety Disorder from the best-estimate diagnostic team. We secondarily examined the factors' relationship to the previously described ADHD Factor Score and K-SADS ODD symptom count to ensure robustness of findings across both dimensional and categorical classification of those disorders.

Aim 3. For all primary longitudinal models, we used the revealed factors. Regarding ADHD, we used one of two types of ADHD measures depending on the co-variates. To predict ADHD-IN and ADHD-HI over time, we used ADHD trajectory scores that were created based on longitudinal analysis of the ADHD-RS. ADHDRS raw scores were binned based on participants' age at each study visit (for further details on this process, see (Morton, 2023)). Because of data sparsity at the tails of the age range, data at ages 7 and 8 were collapsed into a single bin, as were ages 18-23. Longitudinal growth models, with random intercepts and slopes, were fit using Mplus v8.10. Model fit for all symptom measures (inattention and hyperactivity) was good: TLI>0.98, CFI>0.97, RMSEA<0.03. From these growth models, individually-varying intercepts and slopes for each participant were saved and used as outcomes in our regression models. For the purposes of measurement uniformity, for the ADHD trajectory analyses alone

we used the baseline intercept score from that measure as a covariate to control for baseline ADHD. For all other analysis, we used the existing ADHD Factor Score and ODD K-SADS symptom count at baseline to control for ADHD and ODD, respectively.

To examine other outcomes, we used a series of binary outcomes variables. We analyzed Marijuana and Alcohol use at any point after baseline from any combination of the Customary Drinking and Drug Use Record (CDDR), (Brown et al., 1998) teen KSADS, and Timeline Follow Back method as a yes/no binary variable. We examined a global variable of "developing psychiatric disorder(s)" which is classified as one developing a mood disorder (Major Depressive Disorder and Pervasive Depressive Disorder), anxiety disorder (Separation Anxiety, Social Anxiety, and/or Generalized Anxiety Disorders), and disruptive disorders (Oppositional Defiant Disorder and/or Conduct Disorder) at any time during their participation of the study.

An a priori analysis was planned such that if the relationship with the development of any psychiatric disorder proved significant, we would examine each category individually to test for separate relationships. These variables examined whether anyone who did not have a diagnosis (as classified by our best estimate diagnostic team described above) of that category of disorder at baseline developed one at any time over their time participating in the study, again as yes/no binary variables.

Finally, we examined a dimensional lifetime history of suicidal thoughts, plan/intent, and/or attempt. Suicidality was coded across 5 levels based on responses from semi-structured interviews (K-SADS-PL, SCID) and self-report questionnaires (CDI, YSR/ASR). Levels ranged from (0) meaning no thoughts of suicide, through thoughts of death, suicidal ideation, suicidal intent and plan, to (4) suicide attempt.

4.3.2. Analysis Plan

Missing Data. For Aim 1 initial exploratory correlations, we ran analysis with complete observations (missingness was very low, with a maximum of N=9 missing cases, due to analysis being run within baseline data). For Aim 2A, due to selecting the dataset based on having a completed Q-Sort, no missingness was observed. For Aim 2B and Aim 3, Missingness was handled by Full Information Maximum Likelihood Parameter estimates with Robust Standard Errors (MLR) in the MPLUS environment with the assumption that data are missing at random (MAR), as MLR is robust to non-normality and non-independence of observations (Muthén & Muthén, 2002; Savalei & Bentler, 2010).

Specific Aim 1. Cross-Sectional Relational Analysis. Preliminary exploratory, cross-sectional data analysis were run in SPSS (*IBM SPSS Statistics for Windows*, 2016) using a series of either Pearson or Spearman correlation matrices, with Spearman for cases in which variables are zero-inflated, i.e., symptom counts (Pimentel, 2009). Hypothesis 1A and 1B were tested in R-Studio.

Hypothesis 1A.: Correlation analysis using a Spearman matrix.

Hypothesis 1A.2: Correlation analysis using a Pearson matrix.

Hypothesis 1A.3: Correlation using a Pearson matrix

Hypothesis 1A.4: Correlation using Pearson matrix.

All Hypothesis 1B correlations were analyzed using Pearson matrices.

The revealed correlations provided both a check on validity, i.e., that the expected associations materialized in analysis, as well as initial structural insights into interdomain and inter non-orthogonal trait relationships.

Specific Aim 2A: We performed exploratory factor analysis to determine the structural relations at baseline among the ADHD-5 and the Four Traits. Selected factor models were chosen in consultation with mentors. This analysis was conducted in R (R Core Team, 2020).

Specific Aim 2B: Regression Analysis. Hypothesis 2: Revealed factors from 2A were analyzed cross-sectionally with the measures of anxiety, depression, and disruptive behavior at baseline and their composite at later timepoints (detailed above in measures), controlling for age, sex and parent income, to determine and compare their predictive validity and relationship to common psychopathology. All regression analyses were conducted in Mplus version 8.9 using the CLUSTER command, with Monte Carlo integration (Muthén & Muthén, 2002) for models requiring Logistic Regression. Significant interaction terms were probed using the online interaction utilities described in Preacher, Curran & Bauer (Preacher et al., 2006).

Specific Aim 3. Longitudinal Regression Models. In Aim 3, we examined how the factors identified in Aim 1 at baseline predicted severity of future outcomes, including (a) symptom change in ADHD, (b) Mood, Anxiety and Behavioral Disorders, (c), suicidality, and (d) alcohol and marijuana usage. This analysis was conducted in Mplus version 8.9 using the CLUSTER command with Monte Carlo integration (Muthén & Muthén, 2002) and FIML for missing data with Robust Standard Errors (MLR). We conducted stepwise regression to analyze incremental effect size as follows: Step 1, the outcome variable with the covariates of child sex assigned at birth, parent income, and ADHD and ODD symptoms (see methods for variable descriptions), Step 2, added the two factor scores and Step 3, added the interaction of the two factors.

Sample Size and Power Analysis

As described, we utilized data from N=844 participants who completed at least baseline Q-Sorts. For Aim 1, N=844 exceeds the requirement for 80% power to detect even a small correlation of .01, and so it can be inferred that power would be above 80% to detect non-zero correlations of practical significance (Looney, 2018). For Aim 2, exploratory factor analysis of 7-9 features provided adequate power, as our ratio of 93-120:1 subject to item ratio well exceeds

the recommended 20:1 ratio guidelines (Costello & Osborne, 2005). For Aim 3, the sample of N=844 exceed the minimum standard of 10 observations per variable, and the preferred standard of 25 observations per variable (Jenkins & Quintana-Ascencio, 2020), even in the most complex model design.

5. Results

As described in the methods section, the cohort's sample demographic and clinical features are shown in **Table 1.**

In all, seven experts completed a total of 13 Q-sorts of ADHD-5 prototypes. All Cronbach's alphas of the prototypes (with two to three raters depending on the construct) showed good to excellent internal validity (.80-.92), save for inattention which had three raters with an alpha of .59. Due to the intrinsic relationship of inattention to the ADHD construct as well as the exploratory nature of this project, we included the inattention prototype for **Aims 1** and **2A**, but it was removed for **Aims 2B** and **3** (see below.) See **Table 2** for expert prototype participation, affiliation, and prototype alphas.

To explore the relationship between the ADHD-5 prototypes, the pre-existing Four Trait prototypes, Child Sex, and Baseline ADHD Score (as measured by the previously described factor score), baseline K-SADS inattentive symptoms, baseline K-SADS hyperactive symptoms, and baseline K-SADS ODD symptoms, a series of bivariate correlations was conducted. These initial correlation analyses aimed to identify how selected dimensions and traits were associated with inattention or hyperactivity symptoms, as well as their relationship to the overall symptom severity. In addition, we examined whether these selected variables showed significant links to ODD/CD symptoms, as well as whether there were any effects related to child sex. See results in **Table 3A and 3B**. It is important to note that the CDS prototype showed notably low correlations to Inattention as well as to the ADHD-RS CDS items (as a mean) as well as the theoretically related TMCQ scales of Inhibitory Control and Attentional Focusing. The other variables performed as expected.

Hypothesis 1A and **Hypothesis 1B** both postulated that novel relationships would be revealed among the ADHD-5 domains as well as between the ADHD-5 and the 4-Traits. The

results are summarized in **Table 4**. Anticipated strong relationships were observed between Irritability and Impulsivity (r=.83, SE=.01, p<.001), Impulsivity and Behavioral Regulation (r=-.94, SE =.004, p<.001), as well as Irritability with both Ego-Resiliency and Negative Emotionality (r=.-85, SE = .009, p<.001; and r=.84, SE =.009, p<.001, respectively). Relationships were moderate between CDS with Inattention (r=.60, SE = .02, p<.001), Impulsivity (-.42, SE = .027, p<.001) and Behavioral Regulation (.44, SE =.026, p<.001). CDS also showed a weaker than expected negative relationship with hyperactivity (-.22, SE = .031, p<.001). Due to these weaker relationships as well as CDS' previously noted weak convergent validity with outside measures of CDS, we proceeded with caution in the usage of this prototype for further analysis.

Hypothesis 2A postulated that the ADHD-5 and the four regulatory traits would converge into three higher-order factors that are related to, but distinct from, the two factors comprising ADHD in DSM-5. **Hypothesis 2A** was supported as shown in **Table 5A**, although important caveats are to be noted (see below) that resulted in using a 2-Factor Model. Determinant testing confirmed the full correlation matrix contained substantial multicollinearity (Field et al., 2013), with several correlations > .90 (**Table 5A**). However, the Bartlett test of sphericity (Bartlett, 1950) was significant ($\chi 2(36) = 14496.82$, $p < .001$) indicating the data were significantly different from the identity matrix. In addition, the KMO Measure of Sampling Adequacy (Kaiser, 1974) which measured in the Meritorious/Good range (KMO MSA = 0.81). Based on these tests, as well as the exploratory nature of this project, it was concluded that latent factors were sufficiently supported to justify the EFA, and analyses therefore proceeded.

Oblique rotation was selected to allow for expected correlations among the factors (Schmitt, 2011). We chose a promax rotation for exploratory factor analysis (Finch, 2006; Matsunaga, 2010; Sass, 2010; Watkins, 2021). To ensure results are robust to rotation method,

we additionally used an oblimin rotation for confirmation (Finch, 2020). Rotations appeared to yield approximately similar loadings (see **Table 5B** and **5C** for promax and oblimin loadings, respectively.)

We followed Velicer et. al's (2000) guidance of utilizing Parallel Analysis (PA) as well as Minimum Average Partial (MAP) to determine the optimal number of factors, considering that PA tends to slightly over extract factors while MAP tends to slightly under extract (Watkins, 2021). Both PA (Garrido et al., 2016) and Visual scree plot (VSP) analysis indicated three factors were present prior to the "elbow" where subsequent eigenvalue differences were minimal (Zoski & Jurs, 1996). Of the three, two had eigenvalues of >1.0. (However, Very Simple Structure (VSS) complexity achieved a maximum of 0.89 with 2 factors, indicating a 2-factor model may be preferable and therefore it was also examined as noted in what follows.

Item loadings were first examined for a three-factor solution. With this solution, at least two of the nine dimensions (ADHD-5 and 4-Traits) traits were loaded on each factor above the threshold. That is, according to the .40-.30-.20 rule (Howard, 2016) (with a slight modification to be .40-.32-.20 (Costello & Osborne, 2005)) each item loaded on to at least one factor above .4, did not load on to any other factor above .32, and there was a loading difference of >= .20 between the primary and alternative factors (Hinkin, 1998). Examination of the factors content suggested these items describe three types of experiences that were labeled: Undercontrol (with the Behavioral Control, Ego-Undercontrol, Hyperactivity, and Impulsivity prototypes loaded), Internalizing (with Cognitive Disengagement Syndrome and Inattention loaded), and Emotional Dysregulation (with Negative Emotionality, Ego Resiliency, and Irritability loaded).

A 2-factor solution was also examined, using the same rotation. All measures of model fit were considerably worse than the 3-factor solution (RMSR .079 for 2-factors rather than 0.008 for 3-factors, RMSEA = .42 for 2 factors and .21 for 3 Factors, TLI = .90 for 3 factors and .62

for two factors, BIC = 2723.16 for 2-factors and BIC = 405.952 for 3 factors). Model fit statistics were nearly identical between rotations (see **Table 6**). In addition, the revealed factors in a 2-factor solution did not align with theoretical constructs in the literature.

However, other issues were considered. The factor labelled Internalizing only had two items loading on it, which is below the recommended minimum of three (Raubenheimer, 2004). Further, the Inattention prototype, as noted earlier, had poor inter-rater agreement (alpha=.59). In addition, as seen in Aim 1, the Cognitive Disengagement Syndrome prototype did not correlate well with either Inattention, the existing items of CDS from the ADHD-RS, or any of the theoretically related scales from the TMCQ. When analysis was run with CDS, but not Inattention, CDS did not reliably load onto either factor, and showed poor model fit (see **Table 5C)**. Due to these challenges, as a final analysis, we re-ran the factor analysis with a 2-factor solution, removing CDS and Inattention from the potential loadings.

This analysis showed a significant Bartlett test of Sphericity ($\chi 2(21) = 10900.19$, $p <$ .000), as well as a KMO of .84, both indicating that latent factors were likely present and EFA was justified even with the two prototypes removed. The Velicer MAP achieved a minimum of .12 with two factors, and PA indicated two factors as well. Model Fit improved significantly over the original 2-factor solution and was comparable to the 3-factor solution, and loadings remained conceptually aligned with what was seen in the three-factor solution, namely an Undercontrol factor score and an Emotional Dysregulation factor score. These revealed factors were used for the remainder of hypothesis testing.

Hypothesis 2B stated that the revealed factors, in this case the Undercontrol factor and Emotional Dysregulation factor, would add incremental predictive value to ADHD and key ADHD-associated psychopathologies; namely Oppositional Defiant Disorder (ODD), Conduct

Disorder, any Mood Disorder, and any Anxiety Disorder, cross-sectionally. **Hypothesis 2B** yielded mixed support. Results are shown in **Table 7A and 7B**.

Recall that again, ADHD, ODD, Conduct Disorder, Any Mood Disorder, and any Anxiety Disorder are categorical (0,1) variables based on best diagnostic estimate team diagnosis. As in all prior models, the models controlled for age, sex, household income, ADHD, and ODD, except for the models with ADHD or ODD as predictors, in which case the non-predictor disorder was still controlled for. We ran additional sensitivity checks for race (as white/non-white) but with no significant changes in any results, so is not further reported. We also secondarily controlled for the interaction of Undercontrol and Emotional Dysregulation to ensure independence of effects. Primary results are summarized in **Table 7A.** To ensure robustness of findings, we also ran the same models using ADHD and ODD as dimensional symptom-count variables instead of diagnostic status as a sensitivity check (see **Table 7B**). For both analysis sets, we additionally note those relationships that survived Bonferroni's correction to control for familywise error, with a new p value cut-off of .01 to account for the five tests performed in each set (Armstrong, 2014).

Significant relationships were seen when ADHD was examined both as diagnostic status and as a dimensional symptom-based variable. In both cases, higher Undercontrol factor and Emotional Dysregulation factor scores predicted higher likelihood of ADHD diagnosis or higher ADHD symptoms, depending on the model (Undercontrol factor on ADHD diagnostic status: β=.52, SE = .04, p<.001, Undercontrol factor on ADHD dimension: β.47, SE = .03, p<.001; Emotional Dysregulation factor on ADHD diagnostic status: β=.25, SE = .04, p<.001, Emotional Dysregulation factor on ADHD dimension: β=.32, SE = .04, p<.001).

Both ADHD diagnostic status and ADHD dimension showed a significant interaction between the Undercontrol factor and the Emotional Dysregulation factor. We investigated the

interaction using the ADHD dimension score to better account for the variability seen in ADHD presentations. Moderation analysis revealed that Undercontrol and Emotional Dysregulation interacted significantly in the prediction of ADHD symptoms (β = -.16, SE = .023, p < .001). In probing the interaction, as can be seen in **Figure 2**, at average levels of Emotional Dysregulation (defined as the mean in this plot; red dashed line), there was a significant positive association between Undercontrol and ADHD symptoms (slope = .47, SE = .03, p < .001). This association was stronger for individuals who were lower on Emotional Dysregulation (defined in this plot as 1 SD below the mean on Emotional Dysregulation; black solid line) (slope = .64, SE = .03, p < .001), and weaker for individuals who were higher on Emotional Dysregulation (defined in this plot as 1 SD above the mean; green dashed line) (slope = .30, SE = .05, p < .001) (significance of difference between two slopes test: t=5.8, p<.001) (Soper, 2024).

When examining ODD as both diagnostic status and as a dimensional score, significant relationships were found (when controlling for ADHD) with both Undercontrol (Diagnostic status: β=.43, SE =.066, p<.001, Dimensional Score: β=.26, SE = .04, p<.001) and Emotional Dysregulation (Diagnostic Status: β = .33, SE = .06, p<.001, Dimensional Score: β=.31, SE=.04, p<.001). A significant interaction effect was found when a dimensional, but not categorical, ODD measure was examined (β=.16, SE = .03, p<.001) (see **Table 7B**). As can be seen in **Figure 3**, at low levels of Emotional Dysregulation (defined in this plot as one standard deviation below the mean; black line), there was no association between Undercontrol and ODD symptoms (slope = .13, SE = .09, p = .16). At mean levels of Emotional Dysregulation (red dashed line), there was a significant positive association between Undercontrol and ODD symptoms (slope = .45, SE = .07, p < .001). This association was higher (slope = .77, SE = .10, p < .001) for children who exhibited high levels of Emotional Dysregulation (defined in this plot

as 1 SD above the mean; green dashed line) (t-test of differences between two slopes: t=2.62, p=.009) (Soper, 2024).

When examining Conduct Disorder as the outcome (important to note the very low base rate at Year 1 of n=9), no significant relationships were found with either Undercontrol or Emotional Dysregulation when ADHD/ODD was measured categorically. However, a significant effect was seen with Undercontrol when ADHD/ODD was measured dimensionally (β=.45, SE =.15, p<.001). This finding should be interpreted with caution due to the low number of diagnosed Conduct Disorder cases at baseline (n=9).

Any Anxiety Disorder as a yes/no category cross sectionally, however, revealed significant relationships with a distinct pattern. A negative relationship between Anxiety and Undercontrol was revealed, (Categorical ADHD/ODD: β=-.26, SE = .05, p<.001, Dimensional ADHD/ODD: β=-.326, SE =.07, p<.001), such that lower levels of Undercontrol (i.e., overcontrol) predicted higher Anxiety, while Emotional Dysregulation showed a significant relationship in the expected direction (Categorical ADHD/ODD: β=.39, SE =.05, p<.001, Dimensional ADHD/ODD: β=.46, SE .052, p<.001) such that more dysregulation was associated with more anxiety.

Depressive disorders (as a yes/no category any/none) did not show a significant a significant relationship with Undercontrol (β=-.06, SE = .071, p<.584) but did with Emotional Dysregulation (β=.23, SE =.066, p<.001) after the other variables were in the model. The same pattern was seen when ADHD/ODD as dimensional variables were included in the model (Undercontrol: β=-.01, SE =.13, p=.94; Emotional Dysregulation: β=.22, SE =.08, p=.004).

Hypothesis 3: Factor Scores at baseline would add incremental predictive utility for future outcomes over and above baseline ADHD and ODD.

Hypothesis 3 results are shown in **Table 8** and show a pattern of differential support for the incremental predictive utility of Emotional Dysregulation and Undercontrol. Results from the binary logistic regression models showed that both the Undercontrol factor and Emotional Dysregulation factor significantly predicted a subset of outcomes when controlling for ADHD, ODD, Sex, and Primary Income. We additionally examined if there was an interaction effect of Undercontrol and Emotional Dysregulation. As noted in methods, these outcomes were examined in stepwise regressions. Betas for models that including significant interaction effects (Step 3 as described in methods) use the betas from those models in the results section. For models without significant interaction effects, I interpret the betas from models without the interaction term (step 2), with all results shown in **Table 8**.

The Undercontrol factor predicted worsening Inattentive Symptoms (β = .19, SE = .05, p < .001). A nominal association with Hyperactive Symptoms did not survive correction (β = .09, se = .05, p=.049). Undercontrol significantly predicted the development of any future Psychiatric Disorder (β=.22, SE = .07, p=.002), which when examined on an individual disorder level revealed a higher likelihood of developing a Disruptive Disorder over time (β = .40, SE =.09, p<.001) (nominal association with future anxiety did not survive correction (β = .16, SE = .073, p<.030)). Undercontrol also predicted Suicidality severity (β=.23, SE = .045, p<.001).

The Emotional Dysregulation factor score and negatively predicted Lifetime Marijuana Usage (β = -.20, SE = .07, p<.007. A a nominal association to alcohol did not survive correction (β=-.17, SE =.08, p=.025). Due to the unexpected negative direction of the findings, an a posteriori sensitivity model was run without ADHD or ODD in the model. The relationship remained, albeit at a weaker coefficient (β-.16, SE = .07, p<.021), indicating the possibility of suppressor effects. Neither Emotional Dysregulation nor Undercontrol predicted Developing a Mood Disorder over time.

6. Discussion

This study endeavored to advance our conceptualization of the heterogeneous presentation of ADHD by incorporating additional relevant clinical dimensions and selected dispositional traits, thereby broadening our understanding of the ADHD phenotypes in childhood and adolescence. Building on a rich history of integrating personality and temperament theories with psychopathology, this study aimed to expand the conceptualization of ADHD beyond its current diagnostic criteria. This approach aligns with the National Institute of Mental Health's Research Domain Criteria (RDoC) initiative, which emphasizes understanding mental health conditions through neurobiologically grounded psychological dimensions rather than traditional categorical diagnoses. By examining ADHD through this multidimensional lens, we aimed to capture the disorder's complexity and variability across individuals, potentially leading to more personalized and effective interventions. Utilizing Q-Sort methodology, we aimed to explore these dimensions and traits using a measurement tool that embraces the challenges of construct definition and measurement variation, with the hope of benefiting future research and providing potential clinical applicability.

6.1. Key Findings and Implications.

Prototype Development. Although not the only purpose of the study, it is worth noting the potential utility of new phenotype measures. This study employed the venerable but underutilized California Q-Sort to derive expert-consensus prototypes capturing key dimensions associated with ADHD - the two DSM-5 symptom domains of inattention and hyperactivity, a broader definition of impulsivity, as well as the related constructs of irritability and cognitive Disengagement Syndrome (CDS). The advantage of this approach is that the construct is operationalized to conform to expert consensus using a common language—making them directly comparable for conceptual as well as empirical similarity. Here, seven clinical experts

created 13 prototypes for the 7 traits. Within trait, the ratings generally showed sufficient interrater reliability or agreement to make them useful for this study.

However, the Inattention (or inattentive ADHD) prototype had a relatively low Cronbach's alpha of .59, suggesting low agreement among experts on its core features at least in the Q-sort environment. Examining the highest and lowest ranked items for the Inattention prototype revealed only one item ("pays attention well and concentrates") had complete consensus as being most strongly uncharacteristic of inattentive children. This highlights expert disagreement and potential heterogeneity in how inattention (or inattentive ADHD) manifests clinically as well as conceptually. One possible explanation is that the dearth of highly agreed-upon inattentive descriptors may reflect an underrepresentation of relevant features for this construct in the Q-sort item pool.

On further investigation and of interest, however, was many of the Q-Sort items that showed strong disagreement in the Inattention prototype sorts related to temperament traits examined in this study, namely emotional and behavioral regulation. These items include “their mood is unpredictable, they change often and quickly,” “They let little problems get to them and they are easily upset; it doesn’t take much to get them irritated or mad,” and “they hold things in, they have a hard time expressing themselves, they’re a little bit uptight.” For all these items, at least one rater ranked as highly similar to a child with inattention (8 or 9 out of 9) and at least one rater ranking it as either neutral, or not like a child with inattention. This type of discrepancy highlights the necessity of the type of research pursued in the present study. As Lahey (2024) suggests, moving towards an integrated model of psychological problem and temperament rather

than simply conceptualizing inattention (in this case) as a list of disparate symptoms will enhance our ability to understand, identify, and treat those who experience it.

The CDS prototype also demonstrated relatively modest interrater reliability (α=.80) (Cortina, 1993) and, surprisingly, negligible correlations with conceptually related measures of inattention, attentional focusing, inhibitory control as measured by the TMCQ, and 4 CDS research items aligned with recommendations from the international Cognitive Disengagement Syndrome Workgroup (Becker et al., 2023). Given these psychometric limitations for the Inattention and CDS prototypes, we proceeded with caution in utilizing them for subsequent study aims and excluded them from the final factor analysis, rendering them relatively insubstantial in informing the final conclusions from the study. Further analysis incorporating the CDS prototype and its predictive utility would certainly be of interest in future studies.

Uncovering Novel Factors. To clarify the interrelationships between the ADHD-5 and the 4 Traits, exploratory factor analyses were conducted. The results were of interest. Two factors emerged, aligning with theoretical models. The first factor, termed "Undercontrol," (which is not identical to the eponymous Block & Block trait, although it includes it) encompassed four prototypes, namely Hyperactivity, Impulsivity, Ego-Undercontrol, and Behavioral Control. This factor conceptually highlighting traits and behaviors that reflect global impulsivity, high activity levels, difficulty with bodily and verbal control, and heightened verbal and emotional expressiveness. This is useful as, as noted before, the form of impulsivity that is currently part of the DSM-5 ADHD criteria is largely limited to verbal impulsivity (American Psychiatric Association, 2022). Therefore this factor allows a level of analysis that examines a wider range of impulsive behavior than that which is currently in the diagnostic criteria.

The emergence of this Undercontrol factor empirically supports existing theoretical models. High levels of hyperactivity and impulsivity are conceptually closely related to low

behavioral control (Eisenberg et al., 2001, 2005; Raghunathan et al., 2022), a relationship that our data strongly corroborates. Underpinning these traits is the broader construct of Ego Control, which exists on a spectrum from Under- to Overcontrol. Ego-Undercontrol represents a temperament characterized by excessive boundary permeability, an inability to delay gratification, and vulnerability to distraction (Block & Block, 1982). The strong interrelationships observed between Hyperactivity, Impulsivity, poor Behavioral Control, and Ego Undercontrol not only align with theoretical expectations but also demonstrate improved predictive value over ADHD alone, as evidenced by our data.

In the real world, it is clear that hyperactivity, impulsivity, ego-undercontrol, and behavioral control are different constructs with different manifestations that are related but distinct. However, the high degree of statistical overlap among all said prototypes within the Undercontrol factor (correlations ≥ 0.91) raises significant questions about the distinctiveness of these constructs within the context of this Q-Sort-based study. It may be more beneficial to consider the behaviors and traits described by the Undercontrol factor holistically, rather than focusing on the potentially limited additive value of treating the separately named prototypes as discrete sets of behaviors. From a Research Domain Criteria (RDoC) perspective, the value of separating the constructs found in this factor is minimal. While delineation may have some theoretical merit for certain questions and future examination, at a practical level and for this study, it is better conceptually to consider Undercontrol as a holistic descriptor that largely describes a wide range of emotionally, cognitively, and physically impulsive traits and behaviors.

We can see this alignment with impulsivity at the item level. The Q-Sort items scoring highest and lowest were remarkably consistent across the four prototypes within the Undercontrol factor. Items most characteristic of children with these traits included: "They are

energetic and full of life," "When they want something, they want it right away, they have a hard time waiting for things they want and like," and "They are a talkative child, they talk a lot." Conversely, items least characteristic of these children were: "They are determined in what they do; they do not give up easily," "They hold things in; they have a hard time expressing themselves; they're a little bit uptight," "They plan things ahead; they think before they do something; they 'look before they leap,'" "They are careful not to get hurt (physically)," and "They think about their actions and behavior; they use their head before doing or saying something." A notable commonality among these statements is their global alignment with impulsivity, even when overlapping with other characteristics. These traits encompass not only the type of impulsivity detailed in the DSM-5 ADHD criteria, including verbal impulsivity, but also provide a more comprehensive portrayal of an impulsive individual who struggles with inhibition, planning, and sustained motivation. Importantly, this profile also highlights potential positive qualities associated with these traits, such as high energy levels, vibrancy, and ease of self-expression. So, while there may indeed be additive value in considering conceptual traits such as Behavioral Regulation and Ego-Control with ADHD, the results of this study indicate that there is most clearly additive value in expanding the definition of impulsivity beyond the brief, primarily verbal symptoms described in the DSM-5.

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Behavioral Regulation and Ego-Control with ADHD, the results of this study indicate that there is most clearly additive value in expanding the definition of impulsivity beyond the brief, primarily verbal symptoms described in the DSM-5.

The second factor derived herein, termed "Emotional Dysregulation," encompasses elements of negative emotionality and maladaptive responses to environmental stimuli. The prototypes in the factor were Irritability, Negative Emotionality, and Ego-Resiliency (which was negatively loaded, so would be considered low Ego-Resiliency). This prototypes in this factor are conceptually aligned. Irritability and Negative Emotionality (as well as personality Neuroticism) are conceptually aligned constructs. Irritability is considered a combination of internalized negative emotional experience and externalized negative affect that is developmentally inappropriate (Blanken et al., 2021)***;*** while Negative Emotionality refers to heightened reactivity to negative situations, and has been strongly linked to problem behaviors and poorer psychiatric outcomes (Brandes et al., 2019; Eisenberg et al., 1996; Eisenberg & Spinrad, 2004; Watson et al., 1988). Ego-Resiliency, the dynamic capacity to flexibly adapt to changing circumstances and problem-solve (Eisenberg et al., 1996), is related to Emotional Regulation (Eisenberg & Spinrad, 2004).

It is important to highlight that emotional dysregulation is not currently part of the formulation for ADHD, in spite of growing evidence that highlights the co-occurrence of it even when it is not attributable to other disorders (Nigg, Karalunas, Gustafsson, et al., 2020; Shaw et al., 2014; Blanken et al., 2021; Colonna et al., 2022; Fernández de la Cruz et al., 2015; McKay et al., 2024; Eyre et al., 2017). This study aligns theoretically with this research and further emphasizes the important, and potentially additive, relationship that emotional dysregulation has to ADHD. Some researchers propose an irritability-characterized ADHD subtype (Karalunas et al., 2018; Nigg et al., 2020; Yue et al., 2022). Our findings that Emotional Dysregulation is

positively correlated with ADHD symptoms and, at least cross-sectionally incrementally predicts comorbidities beyond the core ADHD symptoms affirm previous research on this topic. Examining top-rated items for prototypes defining the Emotional Dysregulation factor reveals a pattern of, unsurprisingly, holistic emotional lability with a tendency towards negative valence. These items include “Is anxious and fearful,” “Tends to brood and ruminate,” “Cries easily” and “Has rapid shifts in mood; is emotionally labile” as well as “Becomes anxious when the environment is unpredictable or poorly structured” and “Is inappropriate in emotive behavior (reactions are excessive, insufficient, or out of context).”

Further, for individuals with and without ADHD, Irritability and Emotional Dysregulation associate with increased liability for depression ((Berking & Wupperman, 2012; Eyre et al., 2017, 2019; Stringaris et al., 2013) and Oppositional Defiant Disorder (Burke et al., 2014), while high Ego-Resiliency has been shown to moderate the risk of depression and social anxiety symptoms (Goryczka et al., 2022; Seo et al., 2022).

Beyond the consideration of a possible ADHD subtype or the predictive value of the emotional dysregulation factor, these findings raise important questions about the dimensionality and trait aspects of emotional regulation. Specifically, they suggest that the dimension of emotional regulation may be of importance for characterizing ADHD, even though it is not included in the current DSM criteria. This dimensional approach to emotional dysregulation in ADHD could provide a more nuanced understanding of the disorder's presentation and associated impairments.

Cross-Sectional Predictive Findings with Novel Factors. Cross-sectionally at baseline, the findings were largely as predicted (See **Table 7A and 7B**). What was clear was that ADHD

was related strongly to Undercontrol and less so but still significantly to Emotional Dysregulation (even when controlling for sex, income, and a diagnosis of ODD).

Interesting was that an interaction effect was observed between Undercontrol and Emotional Dysregulation in the prediction of ADHD symptoms. The association between Undercontrol and ADHD symptoms was stronger for individuals with lower levels of Emotional Dysregulation. Specifically, at average levels of Emotional Dysregulation, there was a significant positive relationship between Undercontrol and ADHD symptoms. However, this association was stronger for those with low Emotional Dysregulation and weaker for those with high Emotional Dysregulation. This suggests that at high levels of Undercontrol, individuals exhibit elevated ADHD symptoms regardless of their Emotional Dysregulation levels. Conversely, at low levels of Undercontrol, ADHD is more heavily influenced by Emotional Dysregulation. These findings indicate a complex interplay between Undercontrol and Emotional Dysregulation in the manifestation of ADHD symptoms. It suggests that the impact of poor behavioral control on ADHD symptoms may be moderated by an individual's ability to regulate their emotions.

Undercontrol and Emotional Dysregulation also significantly and moderately predicted ODD cross-sectionally, when controlling for sex, income, age, and ADHD at baseline. An interaction effect between Emotional Dysregulation and Undercontrol was also observed when examining Oppositional Defiant Disorder (ODD) as an outcome. For children exhibiting low levels of Emotional Dysregulation, no significant relationship was found between Undercontrol and ODD symptoms. However, at average levels of Emotional Dysregulation, Undercontrol was positively associated with ODD symptoms, with this association strengthening further for children demonstrating high levels of Emotional Dysregulation. In these individuals, the combination of poor Undercontrol and difficulties with emotional regulation appeared to confer a particularly heightened risk for ODD symptomatology. These findings suggest that the influence

of emotion regulation systems on ODD symptomatology varies depending on levels of behavioral regulation and impulsivity.

The results emphasize the necessity of considering both self-regulation deficits and emotional dysregulation in understanding the manifestation of ODD symptoms. Self-regulation refers to a broader concept that includes the ability to control both behavior and emotions. Emotional dysregulation, on the other hand, is a specific subset of self-regulation that pertains to difficulties in managing emotional responses. While self-regulation deficits alone may not necessarily lead to ODD, their effects are amplified when accompanied by emotional dysregulation. This observation aligns with Stringaris' (2009b) proposition that ODD, similar to ADHD presentations, may comprise different dimensions, including an irritable component.

Parenthetically, it was noted that Conduct Disorder showed differing results depending on the operationalization of ADHD. This may be because Conduct Disorder was not well represented (baseline n=9). A significant and robust predictive effect of Undercontrol on Conduct Disorder was seen when ADHD and ODD were included in the model as dimensional variables. No such effect was seen when they were included as categorical diagnoses, however.

Undercontrol and Emotional Dysregulation emerged as significantly related to Anxiety, irrespective of how ADHD and ODD were operationalized. However, the directionality of these relationships were opposing. Overcontrol predicted higher anxiety, which aligns with Block's original theory and findings (Block & Block, 1982). It also aligns with other literature that shows positive relationships between behavioral inhibition and anxiety (Buzzell et al., 2017; Schwartz et al., 1999). Higher Emotional Dysregulation predicted higher rates of Anxiety, as was expected.

Notably, ADHD persisted as a significant positive predictor of Anxiety, even after accounting for Undercontrol (or in this case, overcontrol). This finding suggests that the

Undercontrol prototype captures qualities that are quantifiably distinct from the core features of ADHD, at least in the context of its relationship with anxiety.

Emotional Dysregulation emerged as a predictor of Anxiety in the expected direction, aligning with theoretical frameworks that underscore the close association between Emotional Dysregulation and anxiety symptomatology (Eres et al., 2023; Nigg, Karalunas, Gustafsson, et al., 2020). This finding is particularly pertinent given that irritability is recognized as a core diagnostic feature of Generalized Anxiety Disorder (American Psychiatric Association, 2022).

Diagnosis of a Mood Disorder, regardless of operationalization, was significantly predicted by Emotional Dysregulation, again aligning with both diagnostic criteria (Irritability is a symptom of depression in the DSM-5) as well as theory (Block, 1982; Eisenberg et al., 2000). However, the effect only survived a Bonferroni prediction when the categorical measures of ADHD/ODD were included in the model, rather than the dimensional. A notable limitation was that as this sample had low levels of diagnosis of depressive disorders at baseline (n=47) so this finding should be interpreted with caution.

Longitudinal Findings. We additionally aimed to analyze these factors longitudinally to identify potential clinical targets significantly influenced by them. Specifically, our tertiary aim was to determine the incremental predictive value of the novel Undercontrol and Emotional Dysregulation factors on several longitudinal, binary outcome variables as well as dimensional measures in the case of ADHD and Suicidality. We hypothesized that the Undercontrol and/or Emotional Dysregulation factors would predict the future increase of ADHD-IN symptoms, ADHD-HI symptoms, and/or the future onset of Marijuana Use, Alcohol Use, and the onset of Mood, Anxiety, and/or Disruptive Disorders since baseline over and above the existing impacts of ADHD and ODD, and/or Suicidality. For the psychiatric disorders (i.e. any diagnosis of

Mood, Anxiety and/or Disruptive Disorders), we ran further models to determine the relationships of Undercontrol or Emotional Dysregulation to their new onsets.

The finding that Undercontrol robustly predicted worsening (slope) ADHD-IN symptoms over and above baseline (intercept) inattentive symptoms aligns well with the existing research on the evolution of ADHD presentation. It is intriguing that Undercontrol, which is heavily aligned with Hyperactive/Impulsive symptoms, significantly predicted the worsening of ADHD-IN symptoms over time. This observation is consistent with the general trend observed in the literature, where hyperactive/impulsive symptoms tend to diminish with age, while inattentive symptoms persist or even worsen in adolescence and early adulthood (Vergunst et al., 2019). The robust association between Undercontrol and the worsening of inattentive symptoms suggests that the domains contributing to Undercontrol, such as poor self-regulation and impulsivity, may play a significant role in the persistence and exacerbation of inattentive symptoms during this developmental period.

The nominal finding that Undercontrol and Emotional Dysregulation predicted hyperactive symptom severity (which is likely better considered persistence, rather than increase, of hyperactivity as hyperactivity is known to decrease with age (Mick et al., 2004)) at ages 17-18 aligns with the theoretical underpinnings of these constructs and their expected associations with ADHD symptomatology. However, that this effect did not survive correction so should be interpreted with caution.

Undercontrol also predicted the development of new psychiatric disorder onset over time, beyond the baseline utility of ADHD and ODD. Probing this finding by examining the results by

disorder type revealed that Undercontrol specifically and unsurprisingly added incremental value in predicting the development of new onset Disruptive Disorders.

Our longitudinal analysis of Anxiety Disorder diagnosis revealed an interesting contrast to the cross-sectional findings. Initially, ADHD symptom level appeared to be a significant predictor of such a diagnosis. However, after including Undercontrol and Emotional Dysregulation in the model, ADHD's predictive power disappeared. This suggests that Undercontrol, along with levels of Ego-Control and Behavioral Regulation, may account for the effect previously attributed to ADHD. This shift could be due to the changing impacts of ADHD and/or Undercontrol as children grow older, compared to their effects in early childhood. However, we caution against drawing strong conclusions from this finding, as the predictive power of the longitudinal model was relatively weak.

Perhaps of most importance, Undercontrol modestly but significantly predicted future suicidality severity, encompassing suicidal thoughts, plans, and intent over and above baseline ADHD, ODD, age, sex and family income. While baseline suicidal/self harm thoughts were not controlled for, this suggests clinical utility and underscores the importance of incorporating temperament traits to enhance clinical care. Given that suicide is the second leading cause of death among adolescents (Lahey, 2024; VanOrman & Jarosz, 2016), identifying and targeting early indicators of suicidality is imperative for effective suicide prevention efforts. Youth with ADHD are at increased risk for suicide, especially when comorbidity is present (see (Balazs & Kereszteny, 2017) for a review). It was surprising that Emotional Dysregulation did not predict suicidality, and warrants future investigation.

Unexpectedly, our results indicated that Emotional Dysregulation modestly and negatively predicted future alcohol and marijuana use after baseline assessment. Specifically, higher levels of Emotional Dysregulation were associated with a lower likelihood of trying

marijuana (and nominally, with a lower likelihood of trying alcohol), or put another way, better regulation predicted more drug use. This counterintuitive finding warrants further exploration or at least, speculation to guide further work. While the effect can potentially be explained statistically as due to a suppressor effect, there is also potential theoretical backing for this finding. One possible explanation relates to the role of peer socialization in substance use initiation.

Marijuana use, in particular, is heavily influenced by peer socialization processes (Brook et al., 2016; Salvy et al., 2014). However, emotional dysregulation as a construct has been linked to impairments in social functioning (Eres et al., 2021, 2023; Tan et al., 2022). Adolescent drug experimentation (but not dependence), particularly with marijuana, has been associated with better social adjustment than those who had never experimented with any drug (Shedler & Block, 1990). It is possible that the social difficulties associated with emotional dysregulation may reduce opportunities for peer socialization and, consequently, decrease the likelihood of engaging in at least some aspects of substance use.

Alternatively, the negative association between Emotional Dysregulation factor scores and substance use could be explained by increased likelihood of receiving medication treatment for co-occurring ADHD symptoms. As observed in both the literature and the present study, children with high levels of emotional dysregulation often exhibit more severe ADHD symptomatology at baseline. These children are therefore more likely to be given treatment for ADHD. Notably, several studies have demonstrated that treatment with ADHD medication is associated with a lower risk of subsequent substance use over time (Chang et al., 2014; Groenman et al., 2013; McCabe et al., 2016; Quinn et al., 2017). Thus, the negative association

between Emotional Dysregulation factor scores and substance use may be partly attributable to the protective effects of ADHD medication in this particular cohort.

6.2. Strengths and Future Directions

This study had several notable strengths. First, utilizing Q-sort prototypes allowed expert consensus on construct measurement, moving beyond constraining diagnostic criteria to incorporate rich clinical expertise and a person-centered approach. Second, the large, longitudinal, community-recruited Oregon ADHD-1000 cohort provided ample power to robustly examine long-term outcomes related to the ADHD population.

Incorporating traits like those encompassed in our constructs of Undercontrol and Emotional Dysregulation factor scores enhanced predictive power beyond ADHD diagnosis and ODD symptoms. This aligns with the heterogeneous trait profiles observed in ADHD (Amos et al., 2017; Blanken et al., 2021; Bouvard et al., 2012; De Pauw & Mervielde, 2011; Martel, 2009b; Martel et al., 2011, 2014; Martel & Nigg, 2006). Accounting for such traits could improve case conceptualization and clinical prediction of outcomes. For example, as observed in the diverse responses to the Inattention prototype, there is wide discrepancy amongst experts of the trait disposition of those with inattention. Learning if, and what, traits are aligned with ADHD presentations will help more easily identify those at risk for developing the disorder. This may be of particular importance for those patients who are currently more challenging to identify and more frequently underdiagnosed; such as those with attentional difficulties without overt externalizing or problematic behaviors (Hinshaw et al., 2022).

These findings in particular highlight the potential utility of expanding the integration of impulsivity into our understanding, diagnosis and treatment of ADHD. Our findings indicated that the Undercontrolled factor score, which when examined on an item-level embodied numerous items related to the emotional and behavioral correlates of impulsivity, predicted

ADHD, ODD, Anxiety and Mood Disorders over and above baseline ADHD and/or ODD with numerous covariates controlled. It also was longitudinally predictive of ADHD-IN, the development of a disruptive disorder, and suicidality in late adolescence/early adulthood.

The findings additionally underscore the significance of integrating Emotional Dysregulation into the clinical conceptualization, diagnosis, and treatment of ADHD. Emotional dysregulation, especially irritability, is highly comorbid with ADHD yet remains absent from its diagnostic criteria (Breaux et al., 2022; Cardinale et al., 2021; Colonna et al., 2022; Nigg, Karalunas, Gustafsson, et al., 2020; Read et al., 2020; Yue et al., 2022). This study revealed that Emotional Dysregulation predicted baseline ADHD, Oppositional Defiant Disorder (ODD), anxiety, and mood disorders over and above ADHD and ODD symptoms alone. Additionally, it demonstrated potential predictive value for future ADHD symptom persistence. Including this prevalent and impairing aspect of ADHD in clinical practice could significantly enhance treatment effectiveness. Its incorporation may improve clinical evaluation processes and potentially reveal novel treatment targets, leading to better outcomes for individuals with ADHD.

The potential clinical utility of these prototypes and the Q-Sort methodology warrants careful consideration, particularly in terms of treatment implications and identification of heterogeneous ADHD presentations. While the computerized version of the Q-Sort offers advantages over traditional paper-based methods, it still requires a significant time investment of approximately 30 minutes per administration. In the current healthcare landscape, characterized by increasingly brief clinical encounters and competing demands on clinicians' and parents' time, widespread adoption of such a protocol may face practical challenges. Nevertheless, the consistency observed in the highest and lowest ranked items, especially within the Undercontrol factor, suggests a promising avenue for future research. Specifically, these salient items could inform the development of more concise, targeted scales that capture the broader

conceptualization of impulsivity reflected in this study. Such instruments could potentially enhance our understanding of impulsivity in ADHD and contribute to more nuanced diagnostic and treatment approaches.

Overall, this work supports moving towards a more dimensionally integrated and neurobiologically-informed model of ADHD and related disorders, consistent with the RDoC framework (Costa Dias et al., 2015; Gustafsson et al., 2021; Karalunas et al., 2021; Musser & Raiker, 2019; Zhang et al., 2024). Solely relying on segregated diagnostic categories may miss important sources of heterogeneity relevant for patient-tailored assessment and treatment. Future research should further elucidate the clinical implications of integrating emotional, cognitive, neurobiological and temperamental domains when conceptualizing and treating ADHD and commonly co-occurring conditions.

7. Context and Limitations

Several critical considerations warrant discussion to contextualize these findings. Foremost among these is the exclusion of two key prototypes integral or strongly related to ADHD: Inattention and Cognitive Disengagement Syndrome (CDS). The Inattention prototype did not demonstrate sufficient reliability to be incorporated into our prediction analyses in Aim 3. The omission of inattention, a core dimension of ADHD, potentially limits the comprehensiveness and generalizability of our results. We additionally excluded the CDS variable due both to its questionable validity as well as the fact that it did not reliably load onto any factor in analysis. However, it would be premature to conclude that CDS, or the CDS prototype, lacks significance as a predictor of cross-sectional or longitudinal outcomes. Notably, the CDS construct exhibited moderate interrater reliability among field experts, suggesting its potential utility in future research. Further investigation into both constructs, particularly the

predictive value of the CDS prototype and the validation of this measures, represents a crucial direction for subsequent studies.

In addition, our factor analytic models revealed high rates of multicollinearity, especially for the variables loaded onto the Undercontrol factor. While high correlation was expected due to both the conceptual overlap and the homogeneity of measurement (all prototypes sorted the same 100 items), future research should include more construct-specific items to ensure appropriate differentiation of the prototyped constructs. As discussed previously, this is particularly important in the Undercontrol factor, in which the prototypes had an overlap of .91 and above, indicating that at least in this context, each prototype may be considered different terminology for grossly similar phenomenon. The prototypes that loaded on to the Emotional Dysregulation factor did not exhibit multicollinearity.

Second, most of the longitudinal outcome measures, save for ADHD and Suicidality used in this study were binary and non-dimensional, failing to capture the severity or intensity of the outcomes. While dimensional approaches offer nuanced insights into symptom severity, categorical diagnoses remain the predominant framework in clinical settings. By utilizing diagnostic categories, our research aims to enhance its translational value and immediate applicability to real-world clinical scenarios.

Our decision to use categorical and grouped diagnoses (e.g., Anxiety Disorders as a category rather than individual anxiety diagnoses) was additionally motivated by statistical considerations. By consolidating related disorders into broader diagnostic categories, we reduced the number of statistical tests performed, thereby decreasing the probability of Family-Wise Error Rate (FWE). This strategy enhances the robustness of our findings, ensuring that significant results are more likely to represent true effects rather than statistical artifacts. While

this method sacrificed some granularity, it provides a more conservative and reliable analytical framework. Future research in these constructs should explore the relationship between Undercontrol/Emotional Dysregulation and symptom severity, as well as usage levels for Marijuana/Alcohol.

Regarding Marijuana usage, it is important to note that in the state of Oregon in which this research was conducted, marijuana was legalized in 2015, which potentially had an impact on normative adolescent usage and experimentation. While extensive and large-scale metanalysis examining more than a million youth across the United States did not see an increase in adolescent marijuana usage, and indeed has seen some decreased likelihood of use, in states with legalized marijuana (even when including the expansion of retail availability as a co-variate) (Anderson et al., 2024; Coley et al., 2024), it is still of importance to consider the impact of accessibility and ease of acquiring of marijuana in adolescent drug use research. In the future, within this cohort, it would be of value to more closely analyze the particular level of usage, both before and after legalization, to determine if what is being seen in this study is genuine usage or experimentation, which in turn would impact the interpretation of our findings.

Another limitation is that, while the sample cohort was representative of the catchment area for the study, it was not adequately powered to examine subgroups of participants from diverse and in particular non-white racial/ethnic backgrounds. Although sensitivity analysis showed no significant relationship with white/non-white racial status, these findings should be interpreted with the predominantly white cohort in mind. It is of the for clinical research to include racially and demographically diverse participants in clinical ADHD research, and to not generalize findings of predominantly white cohorts to the population at large. Considering the differing ADHD presentations, diagnosis and treatment rates, and outcomes that are seen in those

from non-white backgrounds (Alai et al., 2024; Bergey et al., 2022; Coxe et al., 2021), ensuring further representation and engagement in this type of clinical research with non-white populations is a pressing future direction.

In addition, the study only examined children based on sex assigned at birth, rather than gender identity, due to the lack of available data on gender identity from early years of collection. As there is both a growing interest in, as well as a paucity of, research into the relationship of gender diversity with neurodevelopmental disorders, the inclusion of gender identity variables into both data collection and data analysis is a vital future direction (Goetz & Adams, 2024; Becerra-Culqui et al., 2018; Delozier et al., 2020).

It is also important to note that not every potential trait was examined; this was not an attempt at a comprehensive trait model but at major traits related to regulation. Further investigation on the interactions of other dispositional traits may indeed reveal fruitful relationships to and with ADHD.

In addition, there are at least two other co-variates that have been shown to have strong relationships to ADHD trajectories over time that were not included, and should be considered important for future study to confirm effects. While we included socioeconomic status (SES) as measured by parental income as a baseline covariate, we did not track change in family income level over time. It would be important to include this in future studies to ensure that improving or worsening symptomatology is not better explained by financial status, which has been shown to improve access to treatment and global outcomes (Holz et al., 2015; Russell et al., 2016).

In addition, we did not include or track parent ADHD diagnosis or other psychopathology, which is well-known to strongly contribute to childhood ADHD diagnosis rates and symptomatology (Moroney et al., 2017; Perez Algorta et al., 2018).

Finally, the volunteer sample may not fully represent the entire range of ADHD and ODD severity, considering the relatively low rates of ODD (and CD) in the ADHD community-recruited sample. This potential limitation should be considered when interpreting the findings.

Summary and Conclusion

The present study examined the heterogeneity of ADHD from a dimensional perspective by integrating associated clinical dimensions and temperament/personality trait models. This approach acknowledges the need to refine our phenotypic understanding of ADHD beyond the core symptoms of inattention and hyperactivity/impulsivity.

In addition to these core ADHD dimensions, we explored impulsivity, Cognitive Disengagement Syndrome (CDS), and irritability as associated clinical dimensions. Impulsivity, while partially captured in the ADHD criteria, encompasses a broader spectrum of behavior, including non-reflective responses to stimuli and preference for immediate rewards. CDS, previously known as sluggish cognitive tempo, is a constellation of symptoms distinct from ADHD-inattention, including mental fogginess and lethargy. Irritability, characterized by frequent anger outbursts and low frustration tolerance, is increasingly recognized as a prevalent feature in individuals with ADHD.

To understand how these clinical dimensions intersect with ADHD, we drew upon classic temperament/personality trait models, including the Block and Block model (Ego-Resiliency and Ego-Control), and the Eisenberg et al. model (Behavioral Regulation and Negative Emotionality). These models offer a framework for conceptualizing self-regulatory traits that may underlie the expression and development of ADHD and its associated dimensions.

In the context of the methods used, the sample available, and the limitations noted, the findings contribute to the growing body of literature that advocates for a dimensional approach to psychopathology in general and to ADHD phenotyping in particular. By integrating associated

clinical dimensions and temperament/personality trait models, we aim to provide a more nuanced understanding of the heterogeneity within ADHD. This approach aligns with the Research Domain Criteria (RDoC) framework, which emphasizes the need to investigate mental disorders from a multi-dimensional perspective, considering neurobiological and psychological constructs.

Ultimately, refining the ADHD phenotype through dimensional models and self-regulatory trait frameworks may inform more personalized assessment, treatment, and intervention strategies. As understanding of ADHD's heterogeneity deepens, clinicians can be enabled to better identify specific clinical profiles and trajectories, leading to improved outcomes for individuals affected.

Table 1. **Demographic Information**

Demographic Information	Cohort (SD)	ADHD**	Typically Developing**
N	844	508	301
Sex (male)	62%	86%	48.50%
Race (non-Hispanic White)	81%	80%	82%
Mean age at intake	9.43(1.56)	9.51(1.52)	9.27(1.59)
Taking Stimulant Medication	23%	38%	0%
ADHD Diagnosis*	60%	100%	0%
ADHD-RS Total (T)	61.2(16.82)	71.53(12.61)	44.62(7.21)
ADHD-RS Hyperactivity (T)	58.98(16.29)	67.68(14.51)	45.14(7.25)
ADHD-RS Inattention (T)	61.7(16.81)	72.18(12.07)	44.73(7.32)
Conners-3 Hyperactivity (T)	62.58(17.42)	71.99(14.83)	47.59(8.73)
Conners-3 Inattention (T)	64.19(16.73)	74.76(11.56)	47.14(7.5)
Child Mood Disorder Dx*	5.60%	7.10%	1.60%
Child Anxiety Disorder Dx*	15.20%	19%	7.90%
Oppositional Defiant Disorder Dx*	11.50%	17.80%	0.06%
Parent Income	4.55(1.9)	4.41(1.97)	4.87(1.73)

Individual Ns for non-white specific race at Year 1 are as follows: 16 – American Indian/Alaska Native, 43 – Asian/East Asian, 57 – Black, Native Hawaiian/Pacific Islander – 7, Declined to Respond/Unknown – 4. * diagnosis based on best-estimate diagnostic team (see Methods) **These categorizations are made on best estimate diagnostic team, and do not include 35 children who were classified as either subthreshold or rule-out at baseline. **Parent Income** – Measured on a scale of 1-8, with 1 being <$25,000 and 8 being >$150,000. 4 is <$75,000, and 5 is <$100,000.
ADHD-RS- ADHD Rating Scale **HYP** – Hyperactive **INT** – Inattentive **Mood Disorder Diagnosis -** Major Depressive Disorder or Pervasive Depressive Disorder **Anxiety Disorder Diagnosis -** Separation Anxiety, Social Anxiety, and/or Generalized Anxiety Disorders **Dx -** Diagnosis

Table 2. Raters and Construct Alphas for the Q-Sort for Aim 1

Raters for the Q-Sort for Aim 1	Cognitive Disengagement Syndrome	Hyperactivity	Impulsivity	Inattention	Irritability
Stephen Becker, PhD, University of Cincinnati	X			X	
Leonard Burns, PhD, Washington State University	X				
Sarah Karalunas, PhD, Purdue University			X	X	
Ellen Leibenluft, MD, Child Mind Institute		X			X
Joel Nigg, PhD, Oregon Health & Science University		X	X	X	
Philip Shaw, B.M. B.Ch., PhD, National Human Genome Research Institute		X			X
Dan Waschbusch, PhD, Penn State University	X				
Alpha	0.80	0.89	0.92	0.59	0.83

Table 3A and 3B. Initial Exploratory Correlations for Aim 1

Exploratory Correlations between Prototypes and Sex, ADHD, ODD and CD (95% Confidence Intervals)

Prototype	SEX (95% CI)	Y1 ADHD Factor (95% CI)	Inattentive Symptoms (K-SADS) (95% CI)
Hyperactive Prototype	-0.103 (-.170, -.036)	0.729 (0.695, 0.759)	0.658 (0.618, 0.695)
Inattentive Prototype	-0.084 (-.151, -.017)	0.653 (0.612, 0.690)	0.604 (0.559, 0.645)
Irritability Prototype	-0.064(-.131, 0.003)	0.636 (0.594, 0.674)	0.569 (0.521, 0.613)
Impulsivity Prototype	-0.086 (-.153, -.019)	0.633 (0.591, 0.672)	0.565 (0.517, 0.609)
CDS Prototype	-0.013 (-.080, 0.55)	0.114 (0.047, 0.180)	0.124 (0.057, 0.190)
Ego Resiliency Prototype	0.085, (.018, .152)	-0.617 (-0.657, -0.574)	-0.565 (-0.609, -0.517)
Ego Undercontrol Prototype	-0.082(-.149,-.015)	0.556 (0.508, 0.601)	0.490 (0.437, 0.540)
Behavioral Control Prototype	0.117(.049, .183)	-0.625 (-0.664, -0.582)	-0.563 (-0.608, -0.515)
Negative Affectivity Prototype	0.014(-.053, .082)	0.437 (0.381, 0.490)	0.387 (0.328, 0.443)
if r>.067, p≤.05. If r>.113, p≤..001			

Prototype	Hyperactive Symptoms (K-SADS) (95% CI)	ODD Symptoms (K-SADS) (95% CI)	CD Diagnosis (95% CI)
Hyperactive Prototype	0.692 (0.655, 0.725)	0.496 (0.444, 0.545)	0.112 (0.045, 0.179)
Inattentive Prototype	0.354 (0.293, 0.411)	0.263 (0.199, 0.325)	0.003 (-0.064, 0.071)
Irritability Prototype	0.558 (0.509, 0.602)	0.583 (0.536, 0.625)	0.129 (0.062, 0.195)
Impulsivity Prototype	0.675 (0.636, 0.710)	0.504 (0.452, 0.553)	0.134 (0.067, 0.200)
CDS Prototype	-0.181 (-0.246, -0.115)	-0.228 (-0.291, -0.163)	-0.137 (-0.202, -0.070)
Ego Resiliency Prototype	-0.417 (-0.471, -0.360)	-0.458 (-0.510, -0.403)	-0.081 (-0.148, -0.014)
Ego Undercontrol Prototype	0.637 (0.595, 0.675)	0.456 (0.401, 0.508)	0.133 (0.066, 0.199)
Behavioral Control Prototype	-0.672 (-0.708, -0.633)	-0.408 (-0.463, -0.350)	-0.109 (-0.176, -0.042)
Negative Affectivity Prototype	0.331 (0.269, 0.389)	0.456 (0.401, 0.508)	0.077 (0.009, 0.143)

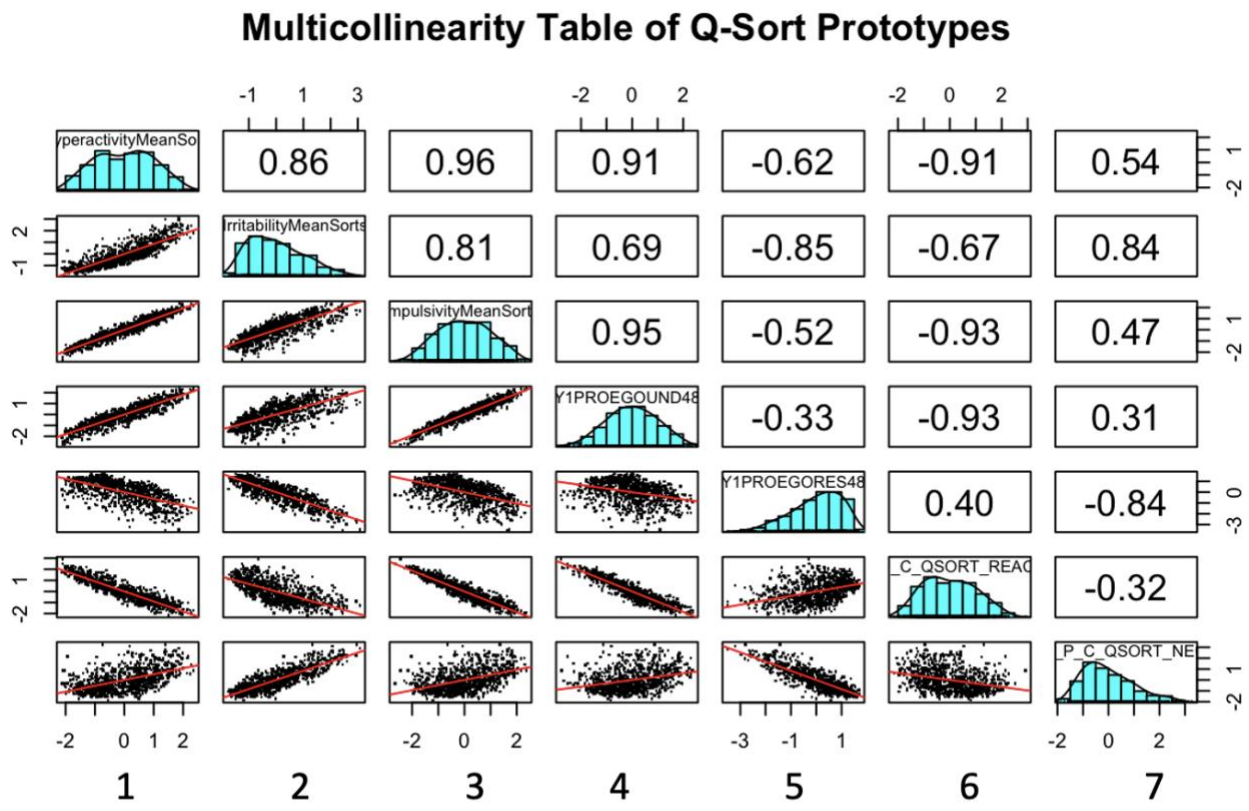
if r>.067, p≤.05. If r>.113, p≤..001, ADHD = Attention Deficit/Hyperactivity Disorder, ODD = Oppositional Defiant Disorder, CD = Conduct Disorder. Prototypes are N=844 children's score on each of the listed constructs.

Prototype/Scale		Correlation (95% CI)
Impulsivity	TMCQ Impulsivity	0.775 (.747, .801)
	TMCQ Inhibitory Control	-0.732 (-.762, -.699)
CDS	ADHD-RS CDS Items Mean	0.007, (-.061, .074)
	TMCQ Activity Level	-0.451 (-.503, -.395)
	TMCQ Attentional Focusing	-0.137 (-.203, -.070)
	TMCQ Inhibitory Control	0.136(.069, .202)
Irritability	TMCQ Negative Affect	0.610 (.565, .651)
if r>.067, p≤.05. If r>.113, p≤.001		

Table 4. Hypothesis 1A and 1B Bivariate Correlations

Hypothesis	r	SE
#1A.1 - CDS and Inattention	0.595	.02
#1A.2 - Irritability and Impulsivity	0.831	.01
#1A.3 - CDS and Hyperactive	-0.221	.03
#1A.3 - CDS and Impulsivity	-0.420	.03
#1B.1 - Impulsive and Behavioral Regulation	-0.937	.00
#1B.1 - Impulsive and Negative Emotionality	0.488	.03
#1B.2 - CDS and Behavioral Regulation	0.443	.03
#1B.3 - Irritability and Block Ego-Resiliency	-0.853	.01
#1B.4: Irritability and Negative Emotionality	0.837	.01
N=844 All ps <.000		

Tables 5A-5C: Hypothesis 2A



1: Hyperactivity 2: Irritability 3: Impulsivity 4: Ego-Undercontrol
5: Ego-Resiliency 6: Behavioral Control 7: Negative Affectivity
Scatterplots represent correlation between different prototypes, with dots closer to the red line indicating Higher correlation. Blue graphs represent distribution of children's scores on individual prototypes.

Table 5B Hypothesis 2A: Final Factor Loadings with the ADHD-5 and 4 Traits (used for Aim2B-3) (Used for Analysis of Aims 2B-3)

Final 2-Factor Solution with Promax Rotation		
	Undercontrolled	Emotional Dysregulation
Behavioral Control	**-1.015**	0.116
Ego Undercontrol	**1.053**	-0.145
Hyperactivity	**0.834**	0.222
Impulsivity	**0.941**	0.058
Irritability	0.369	**0.739**
Negative Emotionality	-0.135	**0.996**
Ego Resiliency	0.058	**-0.954**
Final 2-Factor Solution with Oblimin Rotation		
	Undercontrolled	Emotional Dysregulation
Behavioral Control	**-0.99**	0.08
Ego Undercontrol	**1.03**	-0.11
Hyperactivity	**0.83**	0.24
Impulsivity	**0.93**	0.11
Irritability	0.4	**0.73**
Negative Emotionality	-0.09	**0.97**
Ego Resiliency	0.01	**-0.93**

Table 5C Hypothesis 2A: Other Trialed Factor Loadings with the ADHD-5 and 4 Traits (Not Used)

2 Factor Loadings without Inattentive with Promax Rotation			
	Undercontrolled	Emotional Dysregulation	
Behavioral Control	**-1.015**	0.116	
Ego Undercontrol	**1.053**	-0.145	
Hyperactivity	**0.834**	0.222	
Impulsivity	**0.941**	0.058	
Irritability	0.369	**0.739**	
Negative Emotionality	-0.135	**0.996**	
Ego Resiliency	0.058	**-0.954**	
CDS	-0.659	0.373	

2 Factor Loadings without Inattentive with Oblimin Rotation			
	Undercontrolled	Emotional Dysregulation	
Behavioral Control	**-0.99**	0.08	
Ego Undercontrol	**1.03**	-0.11	
Hyperactivity	**0.83**	0.24	
Impulsivity	**0.93**	0.11	
Irritability	0.4	**0.73**	
Negative Emotionality	-0.09	**0.97**	
Ego Resiliency	0.01	**-0.93**	
CDS	-0.658	0.445	

3 Factor Loadings with Promax Rotation			
	Undercontrolled	Emotional Dysregulation	Internalizing
Behavioral Control	**-1.04**	0.153	0.008
Ego Undercontrol	**1.022**	-0.107	-0.115
Hyperactivity	**0.918**	0.108	0.124
Impulsivity	**0.91**	0.119	-0.097
Negative Emotionality	-0.202	**1.074**	-0.088
Ego Resiliency	0.023	**-0.899**	-0.106
Irritability	0.312	**0.805**	-0.104
CDS	-0.274	-0.092	**0.935**
Inattention	0.287	0.31	**0.726**

3 Factor Loadings with Oblimin Rotation			
	Undercontrolled	Emotional Dysregulation	Internalizing
Behavioral Control	**-1.011**	0.106	0.006
Ego Undercontrol	**0.99**	-0.063	-0.112
Hyperactivity	**0.911**	0.137	0.139
Impulsivity	**0.894**	0.147	-0.082
Negative Emotionality	-0.143	**1.012**	-0.032
Ego Resiliency	-0.032	**-0.853**	-0.155
Irritability	0.345	**0.776**	-0.058
CDS	-0.23	-0.098	**0.932**
Inattention	0.331	0.305	**0.749**
2 Factor Loadings with Promax Rotation			
	Factor 1	Factor 2	
Behavioral Control	**-0.941**	0.019	
Ego Undercontrol	**0.994**	-0.067	
Hyperactivity	**0.844**	0.306	
Impulsivity	**0.958**	0.09	
Irritability	**0.613**	0.477	
Negative Emotionality	0.206	**0.618**	
Ego Resiliency	-0.216	**-0.725**	
CDS	-0.771	**0.845**	
Inattention	-0.012	**1.00**	
2 Factor Loadings with Oblimin Rotation			
	Factor 1	Factor 2	
Behavioral Control	**-0.955**	0.06	
Ego Undercontrol	**0.986**	-0.143	
Hyperactivity	**0.932**	0.214	
Impulsivity	**0.991**	0.004	
Irritability	**0.744**	0.391	
Negative Emotionality	0.368	**0.554**	
Ego Resiliency	-0.406	**-0.652**	
CDS	-0.559	**0.844**	
Inattention	0.249	**0.926**	

Table 6. Model Fit Statistics for the Three Factor Analysis models analyzed – Hypothesis 2A

Model	Promax/Oblimin 3 factor	Promax/Oblimin 2 factor	Promax/Oblimin without Inattention 2 factor	Promax/Oblimin 2 Factor without Inattention/CDS
RMSR	0.008	0.08	0.029	0.012
TLI	0.902	0.62	0.809	0.91
RMSEA	0.22	0.42	0.316	0.24
BIC	405.73	2725.98	1024.31	334.63

RMSR: Root Mean Square Residual (closer to zero indicates better fit), TLI: Tucker-Lewis Index (closer to 1 indicates better fit), RMSEA: Root Mean Square Error of Approximation (closer to zero indicates better fit), BIC: Bayesian Information Criterion (lower indicates better fit)

Table 7A and B: Cross-Sectional Logistic (7A) and Linear/Logistic Regression Models (7B) – Aim 3

Cross-Sectional Table with Diagnostic Status with 2-Factor Model							
Model	Variable	β	Std. Error	p-value	Step-2 β	Step 2 Std. Error	Step 2 p-value
ADHD	**Sex***	**-0.156**	**0.030**	**<.001**	**-0.158**	**0.032**	**<.001**
	Primary Income	-0.026	0.031	0.399	-0.019	0.033	0.566
	Y1 ODD	0.010	0.032	0.750	0.054	0.032	0.085
	Y1 Age*	0.166	0.032	**<.001**	**0.173**	**0.034**	**<.001**
	Undercontrol*	0.514	0.038	**<.001**	**0.519**	**0.043**	**<.001**
	Emotional Dysregulation*	0.234	0.039	**<.001**	**0.252**	**0.041**	**<.001**
	Interaction*				**-0.232**	**0.031**	**<.001**
ODD	**Sex**	-0.111	0.050	0.026	**-0.096**	**0.045**	**0.032**
	Primary Income	-0.088	0.047	0.061	-0.075	0.043	0.080
	Y1 ADHD	0.229	0.082	0.005	**0.184**	**0.083**	**0.027**
	Y1 Age	0.065	0.049	0.184	0.065	0.042	0.123
	Undercontrol*	0.365	0.060	**<.001**	**0.430**	**0.066**	**<.001**
	Emotional Dysregulation*	0.256	0.054	**<.001**	**0.325**	**0.062**	**<.001**
	Interaction				-0.118	0.065	0.071
CD	Sex	-0.007	0.093	0.936	-0.002	0.029	0.939
	Primary Income	-0.069	0.071	0.332	-0.028	0.032	0.373
	Y1 ADHD	0.261	0.228	0.254	0.012	0.020	0.560
	Y1 ODD*	**0.744**	**0.121**	**<.001**	**0.273**	**0.049**	**<.001**
	Y1 Age	0.054	0.059	0.357	0.025	0.021	0.242
	Undercontrol	0.162	0.102	0.115	0.043	0.023	0.066
	Emotional Dysregulation	-0.063	0.075	0.402	-0.048	0.028	0.088
	Interaction				0.038	0.045	0.393
ANXIETY	Sex	0.057	0.053	0.282	0.035	0.034	0.305
	Primary Income*	**-0.162**	**0.054**	**0.003**	**-0.099**	**0.035**	**0.005**
	Y1 ADHD*	**0.197**	**0.066**	**0.003**	**0.104**	**0.041**	**0.012**
	Y1 Age	-0.010	0.050	0.847	0.000	0.042	1.000
	Y1 ODD	0.008	0.051	0.880	-0.003	0.033	0.932
	Undercontrol*	**-0.340**	**0.062**	**<.001**	**-0.260**	**0.047**	**<.001**
	Emotional Dysregulation*	**0.459**	**0.052**	**<.001**	**0.386**	**0.048**	**<.001**
	Interaction				-0.051	0.036	0.165
MOOD	Sex	-0.038	0.082	0.646	-0.012	0.035	0.732
	Primary Income	**0.157**	**0.077**	**0.041**	**0.077**	**0.035**	**0.028**
	Y1 ADHD	**0.253**	**0.118**	**0.032**	0.062	0.046	0.175
	Y1 Age	0.003	0.064	0.968	0.019	0.043	0.657
	Y1 ODD*	**0.216**	**0.071**	**0.002**	**0.101**	**0.035**	**0.004**
	Undercontrol	-0.056	0.102	0.584	-0.025	0.053	0.637
	Emotional Dysregulation*	**0.234**	**0.066**	**<.001**	**0.139**	**0.040**	**0.001**
	Interaction				-0.054	0.036	0.129
bold = p<.05, *survives Bonferroni correction (.01)							
ADHD = Attention Deficit/Hyperactivity Disorder, ODD = Oppositional Defiant Disorder, CD = Conduct Disorder, ANXIETY = Anxiety Disorder, and MOOD = mood disorder, Interaction = Interaction between Undercontrol and Emotional Dysregulation factor scores. All disorders are diagnostic status as defined by best-estimate diagnostic team.							

Cross-Sectional Table with Dimensional ADHD/ODD Scores with 2-Factor Model							
Model	Variable	β	Std. Error	p-value	Step-2 β	Step 2 Std. Error	Step 2 p-value
ADHD	**Sex***	**-0.124**	**0.026**	**<.001**	**-0.115**	**0.026**	**<.001**
	Primary Income	-0.026	0.025	0.312	-0.016	0.025	0.520
	Y1 ODD symptoms	-0.016	0.030	0.590	0.020	0.029	0.490
	Y1 Age*	**0.116**	**0.024**	**<.001**	**0.109**	**0.024**	**<.001**
	Undercontrol*	**0.476**	**0.032**	**<.001**	**0.472**	**0.033**	**<.001**
	Emotional Dysregulation*	**0.294**	**0.034**	**<.001**	**0.324**	**0.035**	**<.001**
	Interaction*				**-0.161**	**0.022**	**<.001**
ODD	**Sex***	-0.077	0.026	0.003	**-0.078**	**0.026**	**0.002**
	Primary Income	-0.033	0.032	0.304	-0.039	0.033	0.226
	Y1 ADHD Symptoms	-0.021	0.038	0.589	0.026	0.038	0.489
	Y1 Age*	0.090	0.028	0.001	**0.087**	**0.027**	**0.001**
	Undercontrol*	0.292	0.040	<.001	**0.263**	**0.038**	**<.001**
	Emotional Dysregulation*	0.369	0.039	<.001	**0.312**	**0.037**	**<.001**
	Interaction*				**0.163**	**0.032**	**<.001**
CD	Sex	-0.024	0.199	0.902	-0.025	0.201	0.903
	Primary Income	-0.138	0.114	0.225	-0.145	0.128	0.255
	Y1 ADHD Symptoms	0.018	0.260	0.946	0.024	0.262	0.926
	Y1 ODD symptoms*	**0.361**	**0.124**	**0.004**	**0.369**	**0.127**	**0.004**
	Y1 Age	0.157	0.097	0.104	0.162	0.099	0.102
	Undercontrol*	**0.465**	**0.131**	**<.001**	**0.450**	**0.151**	**0.003**
	Emotional Dysregulation	-0.143	0.147	0.331	-0.192	0.180	0.286
	Interaction				0.040	0.139	0.774
ANXIETY	Sex	0.054	0.053	0.309	0.058	0.053	0.275
	Primary Income*	**-0.161**	**0.054**	**0.003**	-0.158	0.054	0.004
	Y1 ADHD Symptoms*	**0.228**	**0.071**	**0.001**	0.210	0.072	0.003
	Y1 Age	-0.026	0.053	0.619	-0.014	0.052	0.794
	Y1 ODD symptoms	0.013	0.051	0.799	0.014	0.051	0.788
	Undercontrol*	**-0.355**	**0.066**	**<.001**	**-0.326**	**0.070**	**<.001**
	Emotional Dysregulation*	**0.437**	**0.058**	**<.001**	**0.452**	**0.060**	**<.001**
	Interaction				-0.065	0.049	0.187
MOOD	Sex	-0.030	0.086	0.723	-0.028	0.085	0.738
	Primary Income	**0.163**	**0.076**	**0.032**	**0.162**	**0.075**	**0.030**
	Y1 ADHD Symptoms	**0.271**	**0.122**	**0.026**	0.214	0.124	0.086
	Y1 Age	0.065	0.076	0.393	0.086	0.073	0.236
	Y1 ODD symptoms*	**0.216**	**0.072**	**0.003**	**0.216**	**0.071**	**0.002**
	Undercontrol	-0.098	0.111	0.378	-0.010	0.125	0.939
	Emotional Dysregulation*	**0.175**	**0.085**	**0.039**	**0.224**	**0.079**	**0.004**
	Interaction				**-0.152**	**0.067**	**0.023**
bold = p<.05, * survives Bonferroni correction (.01)							

ADHD = Attention Deficit/Hyperactivity Disorder as a factor score (see methods), ODD = Oppositional Defiant Disorder K-SADS symptom count, CD = Conduct Disorder, ANXIETY = Anxiety Disorder, and MOOD = mood disorder, Interaction = Interaction between Undercontrol and Emotional Dysregulation factor scores. Unless otherwise stated, All disorders are diagnostic status as defined by best-estimate diagnostic team.

Table 8, Model 1-6: Longitudinal Logistic Regression Models

Model 1	β	S.E.	P-Value	β2	S.E.2	P Step 2	β3	S.E.3	P Step 3
ADHD Trajectory - Inattentive Symptoms	Step 1			Step 2			Step 3		
STEP 1									
ADHD inattentive sx at Baseline	**-0.534**	**0.026**	**<.001**	**-0.606**	**0.035**	**<.001**	**-0.590**	**0.037**	**<.001**
Sex	-0.011	0.029	0.709	-0.013	0.029	0.655	-0.015	0.029	0.600
Primary Income	-0.068	0.033	0.037	-0.068	0.032	0.033	-0.071	0.032	0.025
ODD	0.007	0.034	0.846	-0.028	0.039	0.470	-0.044	0.040	0.270
Increment r^2	0.276								
Increment p-value	<.001								
STEP 2									
Undercontrolled*				**0.067**	**0.016**	**<.001**	**0.185**	**0.045**	**<.001**
Emotional Dysregulation				-0.020	0.014	0.157	-0.074	0.042	0.076
Increment r^2	0.295								
Delta r^2	0.019								
Increment p-value	<.001								
STEP 3									
Interaction							**0.066**	**0.029**	**0.020**
Increment r^2	0.299								
Delta r^2	0.004								
Increment p-value	<.001								
Interaction refers to undercontrol x emotional dysregulation interaction, **bold** = significant at .05, * = significant after bonferroni correction (.008)									

Model 2	β	S.E.	P-Value	β2	S.E.2	P Step 2	β3	S.E.3	P Step 3
ADHD Trajectory - Hyperactive Symptoms	Step 1			Step 2			Step 3		
STEP 1									
ADHD Hyperactive sx at Baseline	**-0.560**	**0.033**	**<.001**	**-0.647**	**0.039**	**<.001**	**-0.639**	**0.039**	**<.001**
Sex	-0.037	0.028	0.185	-0.045	0.028	0.099	-0.047	0.027	0.086
Primary Income	-0.049	0.035	0.163	-0.046	0.034	0.181	-0.048	0.035	0.168
ODD	-0.026	0.038	0.496	-0.071	0.041	0.082	-0.081	0.042	0.057
Increment r^2	0.317								
Increment p-value	<.001								
STEP 2									
Undercontrolled				**0.095**	**0.046**	**0.039**	**0.090**	**0.046**	**0.049**
Emotional Dysregulation				0.077	0.039	0.047	0.070	0.037	0.061
Increment r^2	0.327								
Delta r^2	0.010								
Increment p-value	<.001								
STEP 3									
							0.038	0.030	0.207
Interaction									
Increment r^2	0.328								
Delta r^2	0.001								
Increment p-value	<.001								
Interaction refers to undercontrol x emotional dysregulation interaction, bold = significant at .05, * = significant after bonferroni									

Model 3	β	S.E.	P-Value	β2	S.E.2	P Step 2	β3	S.E.3	P Step 3
Lifetime Alcohol Use	Step 1			Step 2			Step 3		
STEP 1									
Y1 ADHD Factor Score	-0.097	0.066	0.141	-0.082	0.083	0.326	-0.068	0.086	0.425
Sex	**0.135**	**0.057**	**0.019**	**0.144**	**0.058**	**0.013**	**0.143**	**0.058**	**0.013**
Primary Income	-0.079	0.061	0.192	-0.084	0.061	0.164	-0.086	0.061	0.155
ODD	0.104	0.063	0.096	0.135	0.069	0.052	0.124	0.071	0.081
Increment r^2	0.037								
Increment p-value	0.074								
STEP 2									
Undercontrolled				0.111	0.080	0.164	0.105	0.081	0.195
Emotional Dysregulation				**-0.169**	**0.076**	**0.025**	**-0.181**	**0.077**	**0.019**
Increment r^2	0.055								
Delta r^2	0.018								
Increment p-value	0.033								
STEP 3									
Interaction							0.047	0.061	0.442
Increment r^2	0.057								
Delta r^2	0.002								
Increment p-value	0.029								
Interaction refers to undercontrol x emotional dysregulation interaction, bold = significant at .05, * = significant after bonferroni correction (.008)									

Model 4	β	S.E.	P-Value	β2	S.E.2	P Step 2	β3	S.E.3	P Step 3
Lifetime Marijuana Use	Step 1			Step 2			Step 3		
STEP 1									
Y1 ADHD Factor Score	-0.112	0.067	0.095	-0.100	0.082	0.222	-0.087	0.084	0.301
Sex	0.057	0.059	0.332	0.067	0.059	0.253	0.066	0.059	0.261
Primary Income	-0.044	0.059	0.454	-0.050	0.059	0.394	-0.052	0.059	0.378
ODD	0.151	0.063	0.016	0.184	0.069	0.008	0.174	0.071	0.014
Increment r^2	0.028								
Increment p-value	0.135								
STEP 2									
Undercontrolled				0.138	0.077	0.071	0.132	0.078	0.091
Emotional Dysregulation*				**-0.197**	**0.073**	**0.007**	**-0.208**	**0.073**	**0.004**
Increment r^2	0.052								
Delta r^2	0.017								
Increment p-value	0.035								
STEP 3									
Interaction							0.044	0.064	0.487
Increment r^2	0.054								
Delta r^2	0.002								
Increment p-value	0.030								
Interaction refers to undercontrol x emotional dysregulation interaction, bold = significant at .05, * = significant after bonferroni correction (.008)									

Model 5A	β	S.E.	P-Value	β2	S.E.2	P Step 2	β3	S.E.3	P Step 3
Psychiatric Worsening	Step 1			Step 2			Step 3		
STEP 1									
Y1 ADHD Factor Score	0.153	0.060	0.011	0.025	0.073	0.733	0.028	0.076	0.711
Sex	0.097	0.052	0.060	0.086	0.052	0.099	0.086	0.052	0.099
Primary Income	-0.134	0.052	0.011	-0.130	0.052	0.012	-0.130	0.052	0.012
ODD	0.163	0.058	0.005	0.090	0.065	0.164	0.088	0.068	0.193
Increment r^2	0.097								
Increment p-value	0.001								
STEP 2									
Undercontrolled*				**0.216**	**0.069**	**0.002**	**0.215**	**0.070**	**0.002**
Emotional Dysregulation				0.031	0.069	0.654	0.029	0.070	0.683
Increment r^2	0.124								
Delta r^2	0.027								
Increment p-value	<.001								
STEP 3									
Interaction							0.010	0.055	0.858
Increment r^2	0.124								
Delta r^2	0.000								
Increment p-value	<.001								
Interaction refers to undercontrol x emotional dysregulation interaction, bold = significant at .05, * = significant after bonferroni correction (.008)									

Model 5B	β	S.E.	P-Value	β2	S.E.2	P Step 2	β3	S.E.3	P Step 3
Disruptive Worsening	Step 1			Step 2			Step 3		
STEP 1									
Y1 ADHD Factor Score	0.196	0.095	0.039	-0.100	0.101	0.325	-0.075	0.104	0.469
Sex	-0.090	0.070	0.198	-0.121	0.069	0.080	-0.123	0.069	0.074
Primary Income	0.019	0.066	0.780	0.031	0.064	0.629	0.027	0.064	0.668
ODD	-0.048	0.108	0.657	-0.230	0.132	0.081	-0.250	0.139	0.071
Increment r^2	0.046								
Increment p-value	0.169								
STEP 2									
Undercontrolled*				**0.410**	**0.095**	**0.000**	**0.398**	**0.094**	**<.001**
Emotional Dysregulation				0.182	0.099	0.067	0.161	0.095	0.091
Increment r^2	0.172								
Delta r^2	0.126								
Increment p-value	0.008								
STEP 3									
Interaction							0.085	0.068	0.212
Increment r^2	0.178								
Delta r^2	0.052								
Increment p-value	0.010								
Interaction refers to undercontrol x emotional dysregulation interaction, bold = significant at .05, * = significant after bonferroni correction (.008)									

Model 5C	β	S.E.	P-Value	β2	S.E.2	P Step 2	β3	S.E.3	P Step 3
Anxiety Worsening	Step 1			Step 2			Step 3		
STEP 1									
Y1 ADHD Factor Score	0.182	0.063	0.004	0.117	0.079	0.136	0.132	0.081	0.104
Sex	0.023	0.056	0.681	0.021	0.057	0.711	0.020	0.057	0.728
Primary Income	-0.065	0.055	0.242	-0.065	0.055	0.240	-0.067	0.055	0.226
ODD	0.138	0.059	0.020	0.111	0.065	0.091	0.099	0.068	0.144
Increment r^2	0.079								
Increment p-value	0.007								
STEP 2									
Undercontrolled				**0.165**	**0.072**	**0.022**	**0.158**	**0.073**	**0.030**
Emotional Dysregulation				-0.053	0.075	0.477	-0.066	0.074	0.376
Increment r^2	0.093								
Delta r^2	0.014								
Increment p-value	0.003								
STEP 3									
Interaction							0.050	0.054	0.354
Increment r^2	0.095								
Delta r^2	0.002								
Increment p-value	0.002								
Interaction refers to undercontrol x emotional dysregulation interaction, bold = significant at .05, * = significant after bonferroni correction (.008)									

Model 6	β	S.E.	P-Value	β2	S.E.2	P Step 2	β3	S.E.3	P Step 3
Lifetime Suicidality	Step 1			Step 2			Step 3		
STEP 1									
Y1 ADHD Factor Score	0.060	0.038	0.110	-0.075	0.046	0.101	-0.086	0.048	0.071
Sex	**0.121**	**0.036**	**0.001**	**0.109**	**0.036**	**0.002**	**0.110**	**0.036**	**0.002**
Primary Income	**-0.096**	**0.037**	**0.010**	**-0.091**	**0.037**	**0.013**	**-0.089**	**0.037**	**0.015**
ODD	0.067	0.039	0.084	-0.011	0.042	0.788	-0.002	0.043	0.963
Increment r^2	0.033								
Increment p-value	0.009								
STEP 2									
Undercontrolled*				**0.229**	**0.044**	**0.000**	**0.234**	**0.045**	**<.001**
Emotional Dysregulation				0.036	0.046	0.439	0.045	0.046	0.337
Increment r^2	0.063								
Delta r^2	0.030								
Increment p-value	<.001								
STEP 3									
Interaction							-0.039	0.036	0.278
Increment r^2	0.064								
Delta r^2	0.001								
Increment p-value	<.001								
Interaction refers to undercontrol x emotional dysregulation interaction, bold = significant at .05, * = significant after bonferroni correction (.008)									

Figure 1. Child and Prototypes As Columns for Individual Score Creation

Q-Sort Statement	Child 1	Child 2	Child 3	Ego-Resilience Child Prototype	Ego-Undercontrol	Hyperactive Prototype	Inattentive Prototype	Irritability Prototype	Impulsivity Prototype	CDS Prototype
Statement 1	3	5	8	3	5.3	4.0	5.7	5.0	4.0	5.0
Statement 2	1	9	8	7	3.3	3.0	6.0	3.5	2.5	6.7
Statement 3	2	9	7	7.7	6.7	4.7	5.7	4.0	5.5	6.0
Statement 4	7	9	2	7	4	3.7	5.0	2.5	3.0	5.7
Statement 5	9	5	1	6.3	3.7	3.3	2.0	2.5	4.0	4.0
Statement 6	8	9	4	6.3	3.7	3.7	5.3	2.5	4.5	6.0
Statement 7	1	6	4	4.7	7	6.3	4.0	4.5	7.0	6.0
Statement 8	2	5	4	3.7	1	3.0	6.0	2.5	2.0	7.3
Statement 9	5	8	8	8	3.7	4.3	4.7	4.0	4.0	5.7
Statement 10	1	1	4	2	9	5.3	3.7	6.0	8.0	4.7

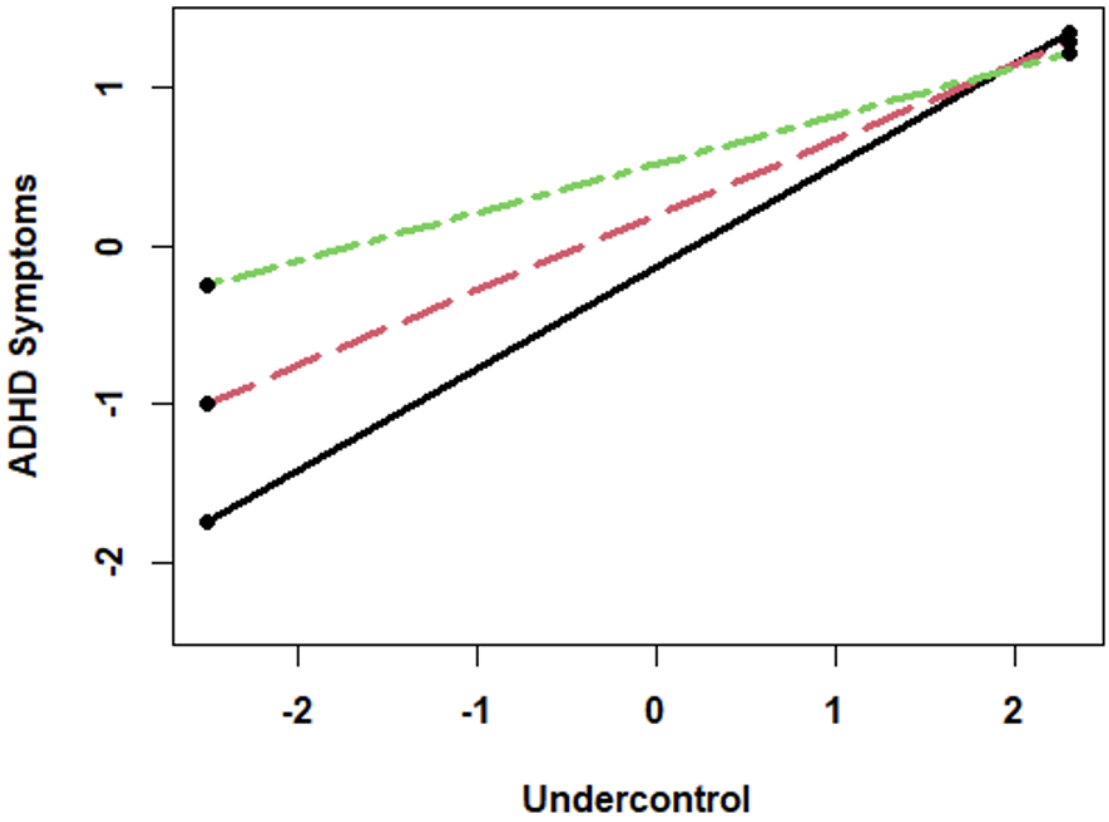
This figure is a sample of how the prototype scores for each child was made. The three children are a subject from the Oregon-ADHD-1000 data set, with the remaining columns the meaned scores from each of the prototypes.

In R, Child 1's parent-rated Q-Sort scores were then correlated with the Ego-Resilience and Ego-Undercontrol prototypes, creating a score of -1 to +1 in terms of relationship to the prototype. R automatically exports this with the data inverted, so that each child becomes a row rather than a column.

This allows the child's individual scores in relationship to the prototype to become a row of the dataset of children each with a single score for each trait instead of the 100 items of their q sort.

Patient	Correlation to Ego-undercontrol Prototype	Correlation to Ego-Resiliency Prototype	Correlation to Hyperactivity Prototype	Correlation to Inattention Prototype	Correlation to Irritability Prototype	Correlation to Impulsivity Prototype	Correlation to CDS Prototype
Child 1	-0.089	0.668	-0.224	-0.106	-0.526	-0.201	0.158
Child 2	0.160	0.599	0.128	-0.079	-0.281	0.113	0.006
Child 3	-0.008	0.633	-0.149	-0.181	-0.419	-0.107	0.005

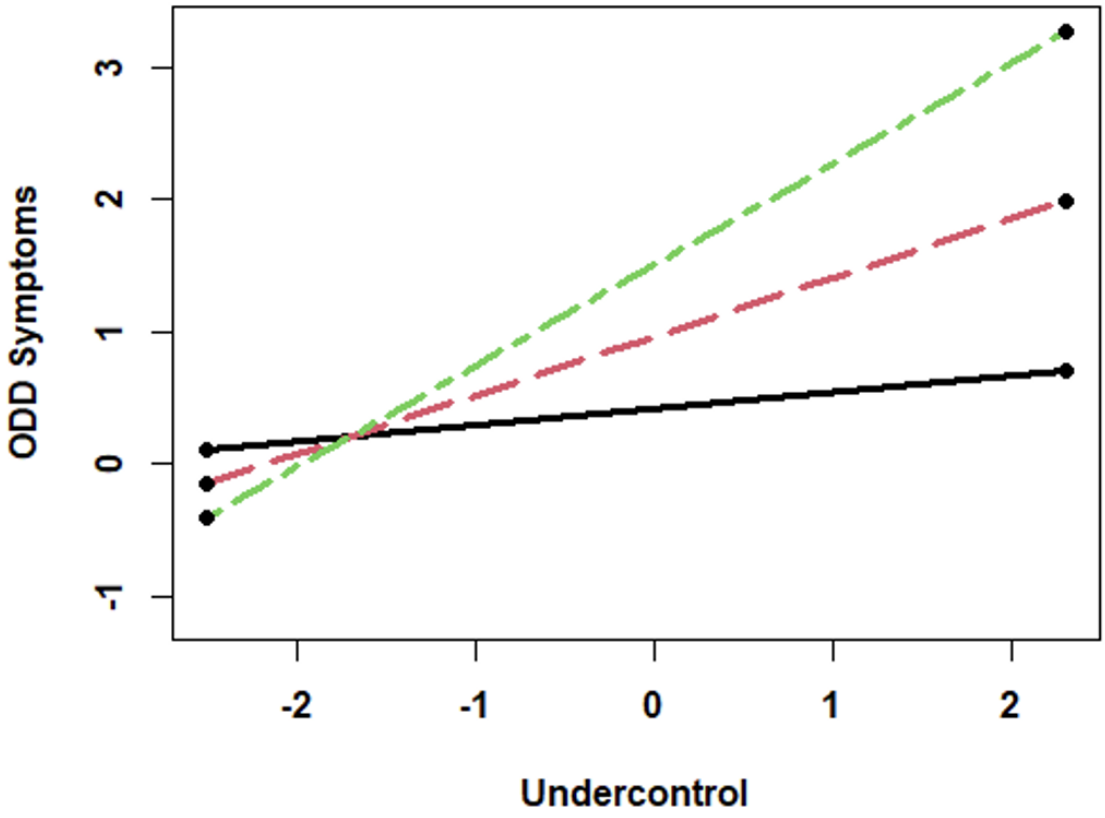
Figure 2: Interaction Effect between Emotional Dysregulation and Undercontrol on ADHD symptoms cross-sectionally (Aim 2)



ADHD = Attention Deficit/Hyperactivity Disorder Factor Score (see Methods)
Black line = Emotional dysregulation 1 SD below the mean
Red dashed line = Emotional Dysregulation mean
Green dashed line = Emotional Dysregulation 1 SD above the mean

The plot shows the relationship between Undercontrol and ADHD symptoms across different levels of Emotional Dysregulation. At average levels of Emotional Dysregulation (mean; red dashed line), there is a significant positive association between Undercontrol and ADHD symptoms. This association is stronger for individuals with lower Emotional Dysregulation (1 SD below the mean; black solid line) and weaker for those with higher Emotional Dysregulation (1 SD above the mean; green dashed line). The difference between these two slopes is statistically significant.

Figure 3: Interaction effect between Emotional Dysregulation and Undercontrol on ODD symptoms cross-sectionally



ODD = Oppositional Defiant Disorder
Black line = Emotional dysregulation 1 SD below the mean
Red dashed line = Emotional Dysregulation mean
Green dashed line = Emotional Dysregulation 1 SD above the mean

The plot depicts the relationship between Undercontrol and ODD symptoms at varying levels of Emotional Dysregulation. At low levels of Emotional Dysregulation (1 SD below the mean; black line), there is no significant association between Undercontrol and ODD symptoms. At mean levels of Emotional Dysregulation (red dashed line), a significant positive association is observed between Undercontrol and ODD symptoms. This association is stronger for children with high levels of Emotional Dysregulation (1 SD above the mean; green dashed line). The difference between these slopes is statistically significant (Soper, 2024).

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9. Appendices

9.1. Appendix I

DSM-5-TR ADHD Criteria

1. Inattention: Six or more symptoms of inattention for children up to age 16 years, or five or more for adolescents age 17 years and older and adults; symptoms of inattention have been present for at least 6 months, and they are inappropriate for developmental level:
    - Often fails to give close attention to details or makes careless mistakes in schoolwork, at work, or with other activities.
    - Often has trouble holding attention on tasks or play activities.
    - Often does not seem to listen when spoken to directly.
    - Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (e.g., loses focus, side-tracked).
    - Often has trouble organizing tasks and activities.
    - Often avoids, dislikes, or is reluctant to do tasks that require mental effort over a long period of time (such as schoolwork or homework).
    - Often loses things necessary for tasks and activities (e.g. school materials, pencils, books, tools, wallets, keys, paperwork, eyeglasses, mobile telephones).
    - Is often easily distracted.
    - Is often forgetful in daily activities.
2. Hyperactivity and impulsivity: Six or more symptoms of hyperactivity-impulsivity for children up to age 16 years, or five or more for adolescents age 17 years and older and adults; symptoms of hyperactivity-impulsivity have been present for at least 6 months to an extent that is disruptive and inappropriate for the person's developmental level:
    - Often fidgets with or taps hands or feet, or squirms in seat.
    - Often leaves seat in situations when remaining seated is expected.
    - Often runs about or climbs in situations where it is not appropriate (adolescents or adults may be limited to feeling restless).
    - Often unable to play or take part in leisure activities quietly.
    - Is often "on the go" acting as if "driven by a motor".
    - Often talks excessively.
    - Often blurts out an answer before a question has been completed.
    - Often has trouble waiting their turn.
    - Often interrupts or intrudes on others (e.g., butts into conversations or games)

    In addition, the following conditions must be met:

- Several inattentive or hyperactive-impulsive symptoms were present before age 12 years.

- Several symptoms are present in two or more settings, (such as at home, school or work; with friends or relatives; in other activities).
- There is clear evidence that the symptoms interfere with, or reduce the quality of, social, school, or work functioning.
- The symptoms are not better explained by another mental disorder (such as a mood disorder, anxiety disorder, dissociative disorder, or a personality disorder). The symptoms do not happen only during the course of schizophrenia or another psychotic disorder.

Based on the types of symptoms, three kinds (presentations) of ADHD can occur:

- *Combined Presentation*: if enough symptoms of both criteria inattention and hyperactivity-impulsivity were present for the past 6 months
- *Predominantly Inattentive Presentation*: if enough symptoms of inattention, but not hyperactivity-impulsivity, were present for the past six months
- *Predominantly hyperactive-Impulsive Presentation*: if enough symptoms of hyperactivity-impulsivity, but not inattention, were present for the past six months.

Because symptoms can change over time, the presentation may change over time as well.

ICD-11 ADHD Criteria (Code: 6A05)

Description

Attention deficit hyperactivity disorder is characterized by a persistent pattern (at least 6 months) of inattention and/or hyperactivity-impulsivity that has a direct negative impact on academic, occupational, or social functioning. There is evidence of significant inattention and/or hyperactivity-impulsivity symptoms prior to age 12, typically by early to mid-childhood, though some individuals may first come to clinical attention later. The degree of inattention and hyperactivity-impulsivity is outside the limits of normal variation expected for age and level of intellectual functioning. Inattention refers to significant difficulty in sustaining attention to tasks that do not provide a high level of stimulation or frequent rewards, distractibility and problems with organization. Hyperactivity refers to excessive motor activity and difficulties with remaining still, most evident in structured situations that require behavioral self-control. Impulsivity is a tendency to act in response to immediate stimuli, without deliberation or consideration of the risks and consequences. The relative balance and the specific manifestations of inattentive and hyperactive-impulsive characteristics varies across individuals and may change over the course of development. In order for a diagnosis to be made, manifestations of inattention and/or hyperactivity-impulsivity must be evident across multiple situations or settings (e.g., home, school, work, with friends or relatives), but are likely to vary according to the structure and demands of the setting. Symptoms are not better accounted for by another mental, behavioral, or neurodevelopmental disorder and are not due to the effect of a substance or medication.

Inclusions

attention deficit disorder with hyperactivity

attention deficit syndrome with hyperactivity

Essential (Required) Features:

- A persistent pattern (e.g., at least 6 months) of inattention symptoms and/or a combination of hyperactivity and impulsivity symptoms that is outside the limits of normal variation expected for age and level of intellectual development. Symptoms vary according to chronological age and disorder severity.

Inattention

- Several symptoms of inattention that are persistent, and sufficiently severe that they have a direct negative impact on academic, occupational, or social functioning. Symptoms are typically from the following clusters:
- Difficulty sustaining attention to tasks that do not provide a high level of stimulation or reward or require sustained mental effort; lacking attention to detail; making careless mistakes in school or work assignments; not completing tasks.
- Easily distracted by extraneous stimuli or thoughts not related to the task at hand; often does not seem to listen when spoken to directly; frequently appears to be daydreaming or to have mind elsewhere.
- Loses things; is forgetful in daily activities; has difficulty remembering to complete upcoming daily tasks or activities; difficulty planning, managing and organizing schoolwork, tasks and other activities.

Note: Inattention may not be evident when the individual is engaged in activities that provide intense stimulation and frequent rewards.

Hyperactivity impulsivity

- Several symptoms of hyperactivity/impulsivity that are persistent, and sufficiently severe that they have a direct negative impact on academic, occupational, or social functioning. These tend to be most evident in structured situations that require behavioral self-control. Symptoms are typically from the following clusters:
- Excessive motor activity; leaves seat when expected to sit still; often runs about; has difficulty sitting still without fidgeting (younger children); feelings of physical restlessness, a sense of discomfort with being quiet or sitting still (adolescents and adults).
- Difficulty engaging in activities quietly; talks too much.
- Blurts out answers in school, comments at work; difficulty waiting turn in conversation, games, or activities; interrupts or intrudes on others conversations or games.
- A tendency to act in response to immediate stimuli without deliberation or consideration of risks and consequences (e.g., engaging in behaviors with potential for physical injury; impulsive decisions; reckless driving)
- Evidence of significant inattention and/or hyperactivity-impulsivity symptoms prior to age 12, though some individuals may first come to clinical attention later in adolescence

or as adults, often when demands exceed the individual's capacity to compensate for limitations.

- Manifestations of inattention and/or hyperactivity-impulsivity must be evident across multiple situations or settings (e.g., home, school, work, with friends or relatives), but are likely to vary according to the structure and demands of the setting.
- Symptoms are not better accounted for by another mental disorder (e.g., an Anxiety or Fear-Related Disorder, a Neurocognitive Disorder such as Delirium).
- Symptoms are not due to the effects of a substance (e.g., cocaine) or medication (e.g., bronchodilators, thyroid replacement medication) on the central nervous system, including and withdrawal effects, and are not due to a Disease of the Nervous System.

Specifiers to describe predominant characteristics of clinical presentation:

The characteristics of the current clinical presentation should be described using one of the following specifiers, which are meant to assist in recording the main reason for the current referral or services. Predominance of symptoms refers to the presence of several symptoms of either an inattentive or hyperactive/impulsive nature with few or no symptoms of the other type.

6A05.0 Attention Deficit Hyperactivity Disorder, predominantly inattentive presentation

- All diagnostic requirements for Attention Deficit Hyperactivity Disorder are met and inattentive symptoms predominate.

6A05.1 Attention Deficit Hyperactivity Disorder, predominantly hyperactive-impulsive presentation

- All diagnostic requirements for Attention Deficit Hyperactivity Disorder are met and symptoms of hyperactivity-impulsivity predominate.

6A05.2 Attention Deficit Hyperactivity Disorder, combined presentation

- All diagnostic requirements for Attention Deficit Hyperactivity Disorder are met and both hyperactive-impulsive and inattentive symptoms are clinically significant aspects of the current clinical presentation, with neither clearly predominating.

6A05.Y Attention Deficit Hyperactivity Disorder, other specified presentation

6A05.Z Attention Deficit Hyperactivity Disorder, presentation unspecified

9.2. APPENDIX II

SCT Symptoms with Convergent Validity on the SCT Factor and Discriminant Validity with the ADHD-Inattention Factor (Becker et al., 2020)

1. My mind feels like it is in a fog
2. I stare off into space
3. I feel sleepy or drowsy during the day
4. I daydream
5. I lose my train of thought
6. I get lost in my own thoughts
7. I get tired easily
8. I forget what I am going to say
9. I feel confused
10. I zone or space out
11. My mind gets mixed up
12. My thinking seems slow or slowed down
13. I have a hard time putting my thoughts into words

9.3. APPENDIX III

California Q-Set Items Significantly Associated with the Four Ego-Control/Ego-

Resilient Undercontroller	Resilient Overcontroller
Energetic, active	Compliant
Curious, exploring	Calm, relaxed
Recoups, resilient	Empathetic
Interesting, arresting	
Brittle Undercontroller	**Brittle Overcontroller**
Restless, fidgety	Inhibited, constricted
Undercontrolling of impulse	Worrying, anxious
Externalizing, vulnerable	Intolerant of ambiguity
Brittle, narrow margin of integration	Rigidly repetitive under stress
Manipulative	Interpersonally reserved
	Withdraws under stress
	Manifests inappropriate affect
	Manifests behavioral mannerisms

Resiliency Conjunctions (Block & Block, 1982)

9.4. APPENDIX IV

California Q-Sort Items (Caspi et al., 1992)

1. They show their thoughts and feelings in the way they look and act, but they do not talk much about what they think and about how they feel.
2. They are considerate and thoughtful of other people.
3. They are a warm person and respond with kindness to other people.
4. They get along well with other people.
5. Other kids look up to them and seek them out.
6. They are helpful and cooperate with other people.
7. They like physical affection. (For example, they like to hug; they like to be held.)
8. They like to keep their thoughts and feelings to themselves.
9. They make good and close friendships with other people.
10. Their friendships don’t last long; they change friends a lot.
11. They try to blame other people for things that they have done.
12. They start to act immature when they face difficult problems or when they are under stress. (For example, they whine or have tantrums.)
13. They try to see what and how much they can get away with; they usually push the limits and try to stretch the rules.

14. They try hard to please other people.
15. They show concern about what's right and what's wrong. (For example, they try to be fair.)
16. They are proud of the things they have done and made.
17. They act very feminine.
18. They let other kids know it when they're upset or angry; they don't hold back their feelings when they feel upset or angry with them.
19. They are open and straightforward.
20. They try to take advantage of other people.
21. They try to be the center of attention. (For example, by showing off, or by offering to do things.)
22. They try to get others to do what they want by playing up to them; they act charming in order to get their way.
23. They are nervous and fearful.
24. They worry about things for a long time.
25. They think things out and you can explain things to them like you can to a grown-up.
26. They are physically active; they enjoy running, playing, and exercise.
27. They look different from other kids their own age. (For example, they are much taller or shorter, under- or overweight, or physically handicapped.) If they don't look different, put this card in the middle pile.
28. They are energetic and full of life.
29. They are protective of others; they protect people who are close to them.
30. Most adults seem to like them.
31. They are able to feel how others feel; they put themselves in their place.
32. They give, lend, and share things.
33. They cry easily.
34. They are restless and fidgety; they have a hard time sitting still.
35. They hold things in; they have a hard time expressing themselves; they're a little bit uptight.
36. They find ways to make things happen and get things done.
37. They like to compete; they're always testing and comparing themselves to other people.
38. They have an unusual way of thinking about things – for better or for worse, they put things together in their head in a different way than other people would.
39. They freeze up when things are stressful, or else they keep doing the same things over and over.
40. They are curious and exploring; they like to learn and experience new things.
41. They are determined in what they do; they do not give up easily.
42. They are an interesting child; people notice them and remember them.
43. They can bounce back or recover after a stressful or bad experience.
44. They give in or back up when they have conflicts or disagreements with others.
45. When they are under stress, they give up and back off.
46. They tend to go to pieces under stress; they get rattled when things are tough.
47. They have high standards for themselves; they need to do very well in the things they do.
48. They need to have people tell them what they're doing well or OK; they are not very sure of themselves.

49. They have specific habits or patterns of behavior. (For example, they tap their fingers on the table, bites fingernails, stutters, bites lips.) If they don't do this, put this card in the middle pile.
50. They tend to get sick when things go wrong or when there is a lot of stress. (For example, they get headaches, stomachaches, throws up.) If they don't do any of this, put this card in the middle pile.
51. They are well coordinated. (For example, they do well in sports.)
52. They are careful not to get hurt (physically).
53. They have a hard time making up their mind; they change their mind a lot.
54. Their mood is unpredictable – they change often and quickly.
55. They worry about not getting their share of toys, food, or love; they seem afraid they won't get enough.
56. They are jealous and envious; they want what other people have.
57. They exaggerate about things that happen to them; they blow things out of proportion.
58. They openly show the way they feel, whether good or bad; they show their emotions openly.
59. They are neat and orderly in the way they dress and act.
60. They get nervous if they're not sure what is going to happen or when it is not clear what they're supposed to do.
61. They judge other people; they have very strong opinions about the things other people do.
62. They are obedient and do what they are told.
63. They are fast-paced; they move and react to things quickly.
64. They are calm and relaxed; easy-going.
65. When they want something, they want it right away; they have a hard time waiting for things they want and like.
66. They pay attention well and concentrate on things.
67. They plan things ahead; they think before they do something; they "look before they leap."
68. They are a very smart kid (even though their grades might not show this).
69. They have a way with words; they can express themselves well with words.
70. They daydream; they often get lost in thought or a fantasy world.
71. They often ask grown-ups for help and advice.
72. They often feel guilty; they are quick to blame themselves, even though they might not talk about it.
73. They have a sense of humor – they like to laugh at funny things.
74. They usually get wrapped up in what they are doing.
75. They are cheerful.
76. They can be trusted; they're reliable and dependable.
77. They feel unworthy; they have a low opinion of themselves.
78. Their feelings get hurt easily if they are made fun of or criticized.
79. They are suspicious – they don't really trust other people.
80. They tease and pick on other kids (including their own brothers and sisters).
81. They can talk about unpleasant things that have happened to them.
82. They speak up and stick up for themselves; they go after what they want.

83. They try to be independent and do things without the help of other people; they try not to rely on other people.
84. They are a talkative child; they talk a lot.
85. They are aggressive. (For example, they pick fights or start arguments.)
86. They like to be by themselves; they enjoy doing things alone.
87. They try to copy and act like the people they admire and look up to.
88. They are self-confident and sure of themselves; they make up their own mind.
89. They are able to do many things well; skillful.
90. They are stubborn.
91. Their emotions don't seem to fit the situation. (For example, they either over-react, doesn't seem to care, or sometimes their reactions just don't make sense.)
92. They are attractive; good looking.
93. They're bossy and like to dominate other people.
94. They whine or pout often.
95. They let little problems get to them and they are easily upset; it doesn't take much to get them irritated or mad.
96. They are creative in the way they look at things; the way they think, work or play is very creative.
97. They like to dream up fantasies; they have a good imagination.
98. They are shy; they have a hard time getting to know people.
99. They think about their actions and behavior; they use their head before doing or saying something.
100. Other kids often pick on them; they're also often blamed for things they didn't do.