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Interrelations among youth temperament, executive functions, and externalizing behaviors

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INTERRELATIONS AMONG YOUTH TEMPERAMENT, EXECUTIVE FUNCTIONS, AND EXTERNALIZING BEHAVIORS

by

Robert David Latzman

An Abstract

Of a thesis submitted in partial
fulfillment of the requirements for
the Doctor of Philosophy degree
in Psychology
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July 2009

Thesis Supervisor: Professor Lee Anna Clark

ABSTRACT

Substantial empirical literatures link executive functioning (EF) and temperament, respectively, to externalizing behaviors (e.g., hyperactivity, impulsivity, conduct problems), but they rarely have been considered jointly. As indices of presumed brain function, neither neuropsychological scores nor temperament traits alone are sufficient as a comprehensive developmental model of externalizing behaviors. The current study aimed to examine the triangular relation among temperament traits, EF, and externalizing behaviors in a community sample of male youth. Participants included 174 male youth 11 to 16 years (M =13.4; SD=1.4) and their mothers. Youth were administered a comprehensive battery of neuropsychological measures tapping the broad domain of executive functions and overall intellectual functioning and completed a personality measure assessing both primary traits and broad temperaments. Mothers reported on their son's temperament and behaviors. Results indicated that, as expected, high Negative Temperament and Disinhibition were associated with both youth and mother reports of externalizing behaviors, with similar cross-informant associations. Specific EF dimensions were correlated with both temperament and externalizing behaviors and provided an incremental contribution above and beyond temperament in explaining externalizing behaviors. Results of the study contribute to the extant literature concerning the dimension of externalizing and inform future research on developing a comprehensive etiological model of externalizing behaviors.

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CERTIFICATE OF APPROVAL

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PH.D. THESIS

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This is to certify that the Ph.D. thesis of

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for the thesis requirement for the Doctor of Philosophy
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To my grandmothers, Shirley and Ida

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ABSTRACT

Substantial empirical literatures link executive functioning (EF) and temperament, respectively, to externalizing behaviors (e.g., hyperactivity, impulsivity, conduct problems), but they rarely have been considered jointly. As indices of presumed brain function, neither neuropsychological scores nor temperament traits alone are sufficient as a comprehensive developmental model of externalizing behaviors. The current study aimed to examine the triangular relation among temperament traits, EF, and externalizing behaviors in a community sample of male youth. Participants included 174 male youth 11 to 16 years (M =13.4; SD=1.4) and their mothers. Youth were administered a comprehensive battery of neuropsychological measures tapping the broad domain of executive functions and overall intellectual functioning and completed a personality measure assessing both primary traits and broad temperaments. Mothers reported on their son's temperament and behaviors. Results indicated that, as expected, high Negative Temperament and Disinhibition were associated with both youth and mother reports of externalizing behaviors, with similar cross-informant associations. Specific EF dimensions were correlated with both temperament and externalizing behaviors and provided an incremental contribution above and beyond temperament in explaining externalizing behaviors. Results of the study contribute to the extant literature concerning the dimension of externalizing and inform future research on developing a comprehensive etiological model of externalizing behaviors.

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INTRODUCTION

Antisocial behavior in childhood typically is characterized by hyperactivity, disinhibition, inattention, oppositional behaviors, defiance, aggression, delinquency, and disregard for the rights of others (Waschbusch, 2002). Epidemiological studies indicate that disruptive, antisocial behavior problems affect 5% to 10% of children and adolescents, and account for over 50% of youth referrals to mental health clinics (Hinshaw, 1994). When such problems are not addressed, antisocial children are likely to experience peer rejection, school problems, difficulty accommodating to the requirements of parents and teachers, and encounters with law enforcement agencies (Loeber, Burke, Lahey, Winters, & Zera, 2000). Moreover, antisocial children often develop into adults who experience high unemployment, low socioeconomic status, poor academic achievement, family problems, legal problems, and many other adjustment difficulties resulting in a troubled adulthood (Waschbusch, 2002). It is abundantly clear in the literature that antisocial behavior in childhood is associated with negative consequences for both the child and those in the child's environment. Thus, increasing understanding of the correlates of antisocial behavior and their roles as risk factors for later behavioral problems is an important task for researchers.

Childhood antisocial and aggressive behaviors have been shown to be a major risk factor for adult antisocial behavior (Huesmann, Eron, Lefkowitz, & Walder, 1984; Robins, 1966, 1978). Huesmann et al. (1984) tracked a group of men and women who had been rated as aggressive by their peers in childhood across 22 years, and found that aggressive children often became aggressive adults. For males, aggressive behavior in childhood also was associated with committing serious criminal acts, abusing their spouses, and driving while intoxicated, whereas aggressive women were more likely to punish their children severely.

Robins' (1966) study of the stability of antisocial behavior compared the adult outcomes of 524 clinic-referred boys and controls. She found that after 30 years, children

exhibiting antisocial behavior were more often arrested and imprisoned as adults, had poorer occupational and economic histories, more marital difficulties,, poorer social and organizational relationships, poorer military records, excessive use of alcohol and, to some extent, poorer physical health. Robins (1978) has since replicated these findings in several different samples. Her research provides a definitive conclusion that childhood antisocial behavior is a strong predictor of adult antisocial behavior. Importantly, however, less than half of the severely antisocial adolescents become antisocial adults. Many of the oppositional and antisocial behaviors that Robins (1966; 1978) and Huesmann et al. (1984) used to predict later antisocial behavior occur at such high frequencies in adolescence that accurately identifying those most likely to persist in antisocial behaviors with great accuracy is difficult. For example, on the basis of preschool antisocial behavior, White, Moffitt, Earls, Robins, and Silva (1990) found that, of 209 children predicted to have antisocial outcomes at age 11, 177 (85%) did not develop the criterion behavior. Therefore, although chronic antisocial individuals typically have a history of antisocial behavior, the reverse is not necessarily true. That is, childhood oppositional and disruptive behavior is so common that it predicts chronic offending only weakly. Because many of the previously employed markers do not predict which children will persist in engaging in antisocial behaviors (Lynam, 1997), it is important to identify additional factors that can identify more precisely the subgroup of children with antisocial behavior who will become antisocial adults.

One avenue that has proven fruitful in increasing the precision of classification is based on the study of individual differences. Early individual differences have the potential to shape children's experiences of and responses to their environment (Caspi, 1998). In relation to externalizing behaviors, a dimension of co-occurring problems that mainly involves conflicts with others and social mores (Achenbach, 1966), two individual differences domains that have been studied widely in the child psychopathology domain are temperament and neuropsychological functioning.

Examined individually, temperament and neuropsychological deficits, particularly deficits in higher order cognitive functioning known as executive functions (EF), have been profitable in identifying potential etiological mechanisms and underlying, predisposing factors in children's externalizing behaviors (Caspi, Henry, McGee, Moffitt, & Silva, 1995; Morgan & Lilienfeld, 2000). Typically, such studies have involved either temperament or specific neuropsychological measures of EF, but not both. Although trait and neuropsychological tasks rarely have been studied together, an integrated investigation may be fruitful and provide information concerning relations among these domains and psychopathology (Nigg, 2000). A substantial theoretical basis exists for suggesting that temperament traits, such as Disinhibition, and performance on neuropsychological tasks, such as those testing EF, may be related, perhaps due to mediation by similar neural mechanisms, or by the interdependent nature of their development. However, even if not directly related, they may provide incremental variance in the prediction of externalizing behaviors. The current study aims to examine the triangular relation between temperamental traits, EF, and externalizing behaviors.

The importance of an externalizing-domain perspective is discussed, followed by a discussion of the major etiological theories of externalizing behaviors that highlights the importance of both temperament and cognitive risk factors in the etiology of externalizing behaviors. A discussion of relevant literature examining associations of temperament and cognitive deficits, specifically EF deficits, with externalizing behaviors follows. The few studies that have examined these domains in concert are then reviewed.

Dimensional Approach

To date, most studies examining links between externalizing behaviors, personality functioning, and neuropsychological functioning have used categorical diagnoses. For example, numerous studies have shown an association between childhood ADHD and adult antisocial personality disorder (Barkley, Fischer, Smallish, & Fletcher, 2004; Loeber, Burke, & Lahey, 2002). Although discrete diagnostic categories may have some

clinical utility, there are numerous problems with the diagnosis and assessment of *DSM* disorders (e.g., Clark, 2007; Watson, 2005), such that faulty diagnosis could spuriously alter results and any conclusions drawn from them (Jang, Vernon, & Livesley, 2001). In contrast, dimensional approaches have proved useful for examining links between personality traits (e.g., neuroticism and extraversion), and the development of psychopathology (e.g., mood disorders; Watson, Clark, & Harkness, 1994). Latent variable modeling work has suggested that common forms of psychopathology (e.g., externalizing) are best conceptualized as continuous in nature (Krueger & Markon, 2006; Markon & Krueger, 2006; Krueger, Markon, Patrick, Benning, & Kramer, 2007).

Externalizing Domain

In a direct comparison of categorical and dimensional models of the occurrence and co-occurrence of externalizing disorders, Markon and Krueger (2006) found that the externalizing dimension of psychopathology is continuous in nature, reflecting an underlying level of risk for disorder that is graded in severity. The understanding that psychopathology can be understood in terms of a hierarchical factor model began with research in the 1960s (Achenbach, 1966), when the term externalizing was first used to describe a broad class of co-occurring problems in children and adolescents that mainly involved conflicts with others and social mores. Extensive evidence indicates that specific externalizing syndromes, such as Conduct Disorder (CD), Oppositional Defiant Disorder (ODD), Attention Deficit/ Hyperactivity Disorder (ADHD), and Substance Use Disorders (SUD), are often comorbid (Achenbach, 1998). The common co-occurrence of externalizing disorders suggests that specific externalizing syndromes are linked at a more basic level (Achenbach, 1998; Kendler, Prescott, Myers, & Neale, 2003; Krueger, 1999; Krueger et al., 2007).

Recently, Lahey, Applegate, Waldman, Loft, Hankin, and Rick (2004) developed an interview to assess symptoms of various disorders found in the two major diagnostic classification systems, the *DSM-IV* and the *ICD-10*. Consistent with the results of

Achenbach (1998) and Krueger (1999), when symptoms were factor analyzed, those consistent with categorical diagnoses such as ADHD, ODD, and CD loaded on a higher order factor, which they labeled externalizing. In other words, specific externalizing syndromes are better conceived as specific manifestations of a common underlying dimension (Krueger, Markon, Patrick, & Iacono, 2005).

A number of empirical studies on externalizing psychopathology support the existence and functional nature of this dimension. Krueger, Caspi, Moffitt, and Silva (1998) modeled comorbidity among *DSM-III-R* disorders in a New Zealand sample assessed at ages 18 and 21 years. At both ages, diagnoses of CD (age 18) or antisocial personality disorder (age 21) and the SUDs formed a single coherent externalizing factor that was clearly distinguishable from a separate internalizing factor. This finding has been replicated by (1) Krueger (1999) with data from the National Comorbidity Survey (NCS), a national survey of community-dwelling individuals between the ages of 15 and 54 years; (2) Krueger, McGue, and Iacono (2001) in a sample of middle-aged parents of twins; (3) Vollebergh et al. (2001) in the general population of the Netherlands; (4) Kendler, Prescott, Myers, and Neale (2003) with twin data from the Virginia Twin Registry; and (5) Slade and Watson (2006) in a large Australian sample of community volunteers.

Structural studies with adult participants have shown that externalizing behaviors are associated with constructs in the broad domain of Disinihibition (Krueger, Markon, Patrick, & Iacono, 2005), the domain of interest in the present proposal. Congruent with data from adults samples, structural studies with children exhibiting externalizing symptomatology have shown associations with high scores on Disinhibition and low scores on Constraint (Lahey et al., 2004).

Genetic research also has provided compelling support for an externalizing spectrum. Krueger et al. (2002) examined the genetic contribution in a sample of 17-year-old twins. Antisocial behavior, CD, SUDs, and an unconstrained personality style were

all connected to a single externalizing factor with a heritability of 81%. Hicks, Krueger, Iacono, McGue, and Patrick (2004) extended this model to include the twins' parents. Results indicated that parent-twin resemblance could be accounted for entirely by genetic transmission of a general externalizing propensity.

Related findings have been reported by Young, Stallings, Corley, Krauter, and Hewitt (2000) from a sample of 12-to-18 year olds. These authors found substantial genetic contributions, 85%, to an externalizing factor linking CD, substance experimentation, ADHD, and novelty seeking. As noted earlier, Kendler et al. (2003) reported similar structural findings in adults, while extending earlier results by distinguishing the externalizing spectrum from the internalizing spectrum at an etiological level. Specifically, SUDs, adult antisocial behavior, and CD formed a single, genetically coherent externalizing factor. Furthermore, genetic influences on this factor were found to be independent of genetic influences on the internalizing factor.

The repeated findings of the presence of undercontrol in externalizing behavior problems has lead several theorists to group these problem behaviors under the general umbrella of disinhibitory psychopathology (Gorenstein & Newman, 1980; Krueger & Markon, 2006). With this in mind, and based on three waves of iterative data collection (N =1787 total), Krueger and colleagues (2007) advanced an integratative quantitative model of this spectrum in adults under which both behavior and personality/temperament is subsumed. Disinhibition, or low Constraint, has been shown to be relatively stable throughout young adulthood, making it an excellent trait to examine in relation to persistence of externalizing behaviors. Across a 10-year period, from age 20 to 30, Constraint yielded cross-age correlations of .58 (McGue, Bacon, & Lykken, 1993). These correlations imply that these individual differences are likely to be preserved throughout time and in diverse circumstances.

Etiological Theories of Externalizing Behavior

Three major etiological theories of externalizing behaviors have been proposed (Moffitt, 1993; Christian, Frick, Hill, & Tyler, 1997; Frick, Cornell, Barry, Bodin, & Dane, 2003; Barry, Frick, DeShazo, McCoy, Ellis, & Loney, 2000; Patterson, DeGarmo, & Knutson, 2000). All three theories have many similarities, the most striking of which--for the current study--is that they include both temperamental and neuropsychological underlying etiological risk factors.

Adolescent-Limited and Life-Course-Persistent Behavior

Moffitt (1993a) has attempted to find factors that identify those children most likely to persist in externalizing behaviors. Her taxonomy distinguishes two types of externalizers: those who engage in adolescent-limited behaviors and those who engage in childhood onset, life-course persistent behavior. Moffitt hypothesizes that adolescent-limited antisocial behaviors, whose onset coincides with the onset of adolescence, arise from peer and social environmental factors, and desist as the adolescent ages. Thus, these children do not continue to exhibit significant antisocial behaviors as adults. It is possible that these children represent the false-positive persisters that are discussed in Robins' (1966, 1978) and Huesmann's (1984) earlier research.

Moffitt hypothesizes a second group of individuals whose antisocial behavior starts prior to age 10, and persists into adulthood. She labels this group the life-course persistent antisocial individuals. The antisocial behaviors exhibited by life-course persistent individuals are hypothesized to arise from a high-risk developmental trajectory. Neuropsychological deficits, such as those leading to hyperactivity and inhibitory problems, and biologically based personality factors, are hypothesized to serve as risk factors. These offenders show a personality profile characterized by impulsive, disinhibited behavior and a cold, callous interpersonal style. In contrast, children showing the adolescent-onset pattern desire more close relationships, yet tend to reject traditional values (Moffitt, 1997).

Although Moffitt's distinction between adolescent and childhood onset groups has proved more fruitful than many previous theories, nearly half of childhood-onset offenders (i.e. Moffitt's hypothesized life-course persistent group) were, in fact, not seriously antisocial individuals at age 18 (Moffitt, 1997). Moffitt (1993b) suggested that identifying different trajectories within the childhood-onset pathway based on EF deficits and attention problems may improve predictive validity. She provides strong evidence of an association between neuropsychological deficits and externalizing behaviors in children, with neuropsychological variation as an early risk factor for both temperamental difficulties and behavioral problems. Consistent with these data, compromised neuropsychological functions have been shown to be associated with a variety of consequences for children in terms of their cognitive development, motor development, and personality development (Rothbart & Derryberry, 1981). Each of the childhood problems that falls within these domains has been linked by research to later externalizing behaviors (Moffitt, 1993).

Similarly, other researchers have suggested that it may be the inattentive, impulsive, and hyperactive behaviors that distinguish a subgroup within the childhood-onset group with a greater likelihood of life-course persistence (Hinshaw, Lahey, & Hart, 1993; Lynam, 1996). Consistent with that hypothesis, several researchers have identified the co-occurrence of Attention Deficit Hyperactivity Disorder (ADHD) symptoms and conduct problems as being highly predictive of chronic antisocial behavior (Hinshaw et al., 1993; Lynam, 1996; Schachar & Tannock, 1995; Waschbusch, 2002).

Waschbusch's (2002) meta-analysis of over 80 relevant studies revealed that children diagnosed with both ADHD symptoms and conduct problems have an elevated risk for future antisocial behavior compared to children with either problem solely. Accumulating evidence suggests that children with comorbid ADHD symptoms and conduct problems, in comparison with children with either problem alone, represent a condition characterized by a strong genetic component (Hinshaw, 1987), severe clinical

symptomatology (Lynam, 1996), increased rates of aggression, and impaired social functioning (Hinshaw et al., 1993).

Callous Unemotional Interpersonal Style

Another way in which the children who show life-course persistent antisocial behavior differ from those who desist may be the presence of a callous-unemotional interpersonal style (Christian, et al., 1997; Frick, Cornell, Barry, Bodin, & Dane, 2003). Frick and colleagues (1997; 2003) have conducted a series of studies that were designed to improve identification of a subgroup of children likely to be life-course-persistent externalizers with fewer false positives, by adding a callous-unemotional interpersonal style as a marker. In a clinic-referred sample of children, most of whom had a substantial number of ADHD symptoms, Christian et al. (1997) were able to identify two subgroups of children who had severe conduct problems with and without high rates of callous-unemotional traits. Children with conduct problems and callous-unemotional traits exhibited conduct problems across more domains, had more contact with the police, and had a stronger history of parental Antisocial Personality Disorder--all factors associated with poor long-term outcome in past longitudinal research (Lahey, Loeber, Hart, Frick, Zhang et al., 1995).

Frick et al. (2003) expanded these findings in a study of 98 children by examining the role of callous-unemotional traits and conduct problems at a one-year follow up. Children with both conduct problems and callous-unemotional traits had higher rates of conduct problems, and showed higher levels of aggression and delinquency at follow up, controlling for initial level of conduct problem severity. Frick and colleagues therefore concluded that it is callous-unemotional traits, regardless of comorbid ADHD symptomatology, that are diagnostic of the subgroup of antisocial children characterized by a particularly severe and aggressive pattern of antisocial behaviors.

While the callous-unemotional style provides one-half of this theoretical approach, Frick and colleagues (Barry et al., 2000) later added inhibitory deficits and other core EF

abilities to their theory, effectively incorporating Moffitt's and Lynam's work with the aim of identifying children within Moffitt's early onset group who are most likely to persist in their externalizing behaviors. Barry et al. (2000) found that children who exhibited ADHD symptoms and conduct problems, as well as callous-unemotional traits, demonstrated a lack of fearfulness and a reward-dominant response style. These children also exhibited an especially severe and violent pattern of antisocial behavior increasing the risk that this behavior will persist.

Coercive Process Model

Patterson and his colleagues (e.g., Dishion, French & Patterson, 1995; Patterson et al., 2000; Patterson, Reid, & Dishion, 1992) have documented the importance of "coercive" parent-child interactions for the etiology of antisocial, aggressive behavior. Patterson's group (e.g., Patterson et al., 1992; Patterson et al., 2000) has emphasized the probable contribution of infant and child individual differences: An extremely active and difficult infant in interaction with an insufficiently responsive parent results in distressed infant behavior that escalates into infant behavior in service of a goal that ultimately is positively reinforced by the parent (i.e., coercive behavior). These coercive behaviors lack social skills and characterize both the hyperactive and the antisocial child, later often resulting in diagnoses of ADHD, ODD, and CD. Once the child begins school, the coercive repertoire that is reinforced by his/her parents generalizes to peers, teachers, and others. The poor reception by teachers and peers results in lessened engagement in school with subsequent academic failure, rejection by normal, nondeviant peers, and association with deviant peers, who contribute to the maintenance and further development of antisocial behavior.

Patterson and colleagues have discussed these early individual differences in terms of both temperamental descriptors and executive control (Snyder, Reid, & Patterson, 2003). Snyder, Reid, and Patterson (2003) discuss three interrelated self-regulation variables as relevant to the development of antisocial behavior: executive attentional

control, motivational inhibition, and negative emotional reactivity. They contend that overlapping neural systems and behavioral functions may be responsible for these deficits. This process is seen as applicable to early starters for adult criminal careers, consistent with the ADHD/CD early onset trajectory discussed earlier. In their model, the regulatory mechanisms of executive attentional dyscontrol, temperamental (dis)inhibition, and negative emotional reactivity all are relevant to the development of externalizing behavior problems.

As previously noted, all three theories reviewed above consist of both temperamental and neuropsychological underlying etiological risk factors. Nigg and Huang-Pollock's (2003) model incorporates these data highlighting the underlying role of early deficits in self-regulation, specifically in emotion regulation and attentional control. Similarly named deficits in both personality traits and behavioral predispositions have been related conceptually to prefrontal cortical circuits and neuropsychological EF (Stuss & Benson, 1984; Rothbart & Bates, 1998), which are major features in many theories of externalizing disorders. This view also appears consistent with Tarter, Alterman, and Edwards' (1985) hypothesis that the prefrontal cortex is involved in both EFs and the regulation of temperament. Taken together, data from these models provide a framework for studying these etiological risk factors in concert to aid in more precise discrimination between those more and less likely to persist in externalizing behaviors beyond adolescence.

Temperament

Many comprehensive theories of severe conduct problems, such as those reviewed above, include temperamental risk factors (Moffitt, 1993; Frick et al, 2003; Patterson et al., 2000). Temperament has been shown to play a role in the etiology and maintenance of externalizing behaviors in both children and adults (Caspi et al., 1995; Caspi & Silva, 1995; Krueger et al., 1994; Lahey et al., 2004). Temperament may constitute a vulnerability that, along with other potential developmental risk factors, is actualized in

the context of certain environments (Patterson et al., 2000; Sanson & Prior, 1999). Although there are a plethora of temperament theories, the proposed study emphasizes trait models that have been particularly influential in psychopathology research and that have an explicit focus on (dis)inhibitory processes.

Modern study of temperament was begun by Thomas, Chess, and Birch (1968), who led the New York Longitudinal Study which examined biologically based temperament traits in children. Temperament is usually conceptualized as biologically based, emotional responses to environmental stimuli (Thomas & Chess, 1977). Nigg (2006) defines temperament as the psychobiology of "individual differences in basic behavioral response styles or dispositional traits" (Nigg, 2006, p. 395). Most contemporary researchers, however, maintain that both hereditary and environmental influences shape temperament (Rothbart & Derryberry, 2002). In so far as personality also is shaped by both genes and environment, personality and temperament often are conceptualized as highly interrelated (Rothbart & Ahadi, 1994; Clark, 2005).

Moreover, there is increasing evidence that temperament and personality are less distinct than previously was assumed (McCrae, Costa, Ostendorf, Angleitner, Hrebickova, Avia, et al., 2000), and it is becoming clearer that it is not fruitful to think of temperament and personality as two distinct constructs (Clark, 2005). At least for higher order traits, both those traits described as temperament and those described as personality are apparent early in life; have similar heritabilities, cross-time and cross-situational stability, and factor structures; appear to be related to both emotional and motivational aspects of behavior (Nigg, 2006), and show similar profiles of genetic and environmental influences on their stability and change (Bouchard & Loehlin, 2001; Saudino, 2005). Additionally, it should be noted that many of these features are shared with psychopathology as well (Krueger, Caspi, Moffitt, Silva, & McGee, 1996) and psychopathology may result, at least in part, when the normal developmental process of temperament/personality goes awry.

One of the major contributions of recent personality psychology is the idea that traits are related to each other in an organized hierarchy. Innate individual differences, which often have been referred to as temperament, form the basis for personality traits organized into robust, higher order personality superfactors (Clark, 2005; Rothbart & Ahadi, 1994; Watson et al., 2005). Temperament and personality differences, in turn, shape the course of development including the development of both prosocial and antisocial behaviors (Rutter, 1987; Shiner, 2006). Research indicates a bidirectional relationship between personality and psychopathology; that is, the presentation of psychopathology depends, in part, on the individual's personality structure (Widiger, Verheul, & van den Brink, 1999). Because temperament and personality traits have so much in common, many contemporary researchers no longer make a sharp distinction between the two and, instead, discuss them together as interrelated (Caspi & Shiner, 2006). Additionally, research has demonstrated the stability of temperament/personality, even at younger ages (Caspi, Roberts, & Shiner, 2005; Roberts & DelVecchio, 2000). In a large meta-analysis, Roberts and DelVecchio (2000) found a moderately large (r= .47) stability coefficient for each of the five factors across ages 12 to 17.9 years. Although this level of stability does not indicate that temperament/personality is immutable across adolescence, it is only moderately lower that the stabilities (r= .57-.62) found in early adulthood, age 22 to 29 years. Temperament, therefore, provides an excellent context for understanding the etiologies and maintenance of behavior problems.

Recently, Clark (2005) asserted that adult personality traits emerge through differentiation from three innate biobehavioral dimensions, two of which are affective, Negative and Positive Affectivity, and the third of which, Disinhibition, is a regulatory system, that plays a role in influencing incoming stimuli (Tellegen, 1985). Thus, the higher order trait of Disinhibition (vs. Constraint) is likely to be the personality dimension most strongly linked to externalizing psychopathology (Krueger, Markon, Patrick, & Iacono, 2005; Lahey et al., 2004). Consistent with Clark (2005), the term

temperament will be used in the current paper to characterize these three higher order dimensions.

Impulsivity-Related Traits

Impulsivity-related traits, often thought to be facets of Disinhibition, have been found to be related consistently to antisocial behavior across a variety of measurement models, samples, and outcome variables (Miller & Lynam, 2001). In a large meta-analysis examining relations between antisocial behavior and traits in various structural models of personality, Miller and Lynam (2001) found that Five Factor Model (FFM) Conscientiousness, Eyesenck's Psychoticism, and Tellegen's Constraint all were related to behavioral undercontrol.

Impulsivity has been viewed by many as a personality characteristic that predisposes individuals to develop long-term, persistent externalizing behaviors (Moffitt, 1993; White, Moffitt, Caspi, Bartusch, Needles, & Stouthamer-Loeber, 1994). Gorenstein and Newman (1980) proposed the existence of an underlying disinhibitory personality style that is expressed as antisocial, externalizing behavior when it occurs in conjunction with particular environmental factors. Moffitt (1993) argued that an impulsive personality style serves to maintain antisocial behavior across the life span. She asserts that impulsivity increases the risk of persistent, long-term externalizing behaviors through both direct and indirect means. Deficits in impulsivity-related traits can produce delinquent behaviors by interfering with children's ability to inhibit problematic behaviors and to think about consequences. Such deficits also may lead to externalizing behaviors indirectly by disrupting a child's success in school and his or her success interpersonally.

A difficult temperament has been associated with behavior problems, delinquency, and aggression. In a synthesis of the early difficult temperament literature, Frick and Morris (2004) assert that certain aspects of temperament related to disinhibition and emotional reactivity, included under the "difficultness" umbrella, can affect the

development of regulatory abilities in early childhood. Dysregulation of these abilities then may serve as predisposing factors in the development of aggressive, antisocial, or delinquent behaviors. Data from the New York Longitudinal Study documented that infants with certain characteristics early in life, labeled as "difficult," tended to have more adjustment problems later in life (Thomas & Chess, 1977). In a prospective study examining the development of aggressive behaviors, Kingston and Prior (1995) found that children with stable aggressive behavior were characterized by a difficult temperament, whereas no association with temperament was found for children with more transient patterns of aggression. Similarly, Sanson, Oberklaid, Pedlow, & Prior (1991) found temperament in infancy to be a modest risk factor for behavioral and emotional adjustment problems at 4 to 5 years of age.

Caspi, Henry, McGee, Moffitt, and Silva (1995) examined continuity of differences in behavioral styles in a sample of boys and girls aged 3 to 15 years. They found that the long-term continuities of individual differences in the behavioral style of Lack of Control were apparent in both sexes. Boys and girls who were characterized by Lack of Control in early childhood were somewhat more likely to experience internalizing problems, but they were especially likely to experience a variety of externalizing problems a decade later, in late childhood and adolescence.

Five Factor Model (FFM)

First, arising from the lexical hypothesis with bottom-up empirical factor analyses of trait adjectives, the FFM emphasizes five broad domains of personality, identified as Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness (Digman, 1990). Research on the Big Five in younger age groups was conducted first by Digman (1989; Digman & Inouye, 1986), who reported several studies of teacher ratings of students ranging in age from 7 to 13 years. Using trait adjectives selected from the adult Big-Five literature, and elaborated by behavioral definitions relevant to classroom behavior, Digman replicated five factors, which he interpreted as childhood equivalents

of the Big Five. Digman (1989) concluded that not only was the FFM robust in children as well as adults, but that these traits appear to be sufficiently in place by the elementary school years to form the basis of reasonable predictions of life outcomes in adolescence and into adulthood.

Lynam, Leukefeld, and Clayton (2003) examined the ability of the FFM to account for the stability of antisocial behavior and substance use/misuse in a longitudinal study of 6th grade students followed until age 21 years. Agreeableness and Conscientiousness were clearly the two most important domains in predicting both antisocial behavior and substance use/misuse. FFM Agreeableness and Conscientiousness have been shown to be components of the yet higher order factor of Disinhibition (Markon, Krueger, & Watson, 2005).

John, Caspi, Robins, Moffitt, and Stouthamer-Loeber (1994) examined the FFM in adolescence using the broad-band item pool of the California Child Q-Set, thus extending measurement of the Big Five dimensions in children beyond adjectives. In relation to both self-reported and teacher-reported delinquency, they found significant main effects for Agreeableness and Conscientiousness. Boys who had committed severe delinquent behaviors were more than three-fourths of a standard deviation lower on Agreeableness and Conscientiousness than boys who had engaged in few or no delinquent behaviors as measured by both self- and teacher report. In addition, significant, but somewhat weaker, effects were found for Extraversion and Openness. No significant differences were found for Neuroticism.

Research also has provided links between FFM personality traits and specific categorical externalizing disorders. For example, Braaten and Rosen (1997) found that individuals with ADHD scored higher on Extraversion and Neuroticism than controls with no CD or ADHD. Nigg et al. (2002) examined relations of the Big Five in adulthood to ADHD symptoms and associated problems recalled from childhood. Consistent with

previous findings, the clear pattern of findings linked ADHD symptoms with low Conscientiousness, low Agreeableness, and high Neuroticism.

Three-Factor Model

A second structural tradition, and the one to be used in the proposed study, has emphasized the importance of three general superfactors of personality. These Big Three models grew out of the seminal work of Eysenck. Eysenck's research resulted in the identification of two very broad factors, which he called Neuroticism and Extraversion (Eysenck, 1959). Subsequent analyses led to the identification of a third broad trait dimension, which he labeled Psychoticism, reflecting aggressive, antisocial, and impulsive characteristics. Despite its name, Eysenck's Psychoticism has been revealed to be more a measure of Disinhibition versus Constraint (Watson & Clark, 1993). It is important to note again that Disinhibition (vs. Constraint) from the three-factor tradition consists of FFM Agreeableness and Conscientiousness in a hierarchical manner (Markon, et al., 2005).

Tellegen (1985; Tellegen & Waller, 1996) reconceptualized Eysenck's dimensions, proposing that both Neuroticism and Extraversion were core affective dimensions, and therefore terming the factors in his model Negative Emotionality, Positive Emotionality, and Constraint. Watson and Clark (1993), building on Tellegen's work, considered how these personality dimensions might link to underlying biological substrates and thus temperaments, namely Negative Temperament (NT), Positive Temperament (PT), and Disinhibition. Despite these terminological and conceptual differences, it should be noted that correlational studies using measures developed to represent each model indicate that they all define virtually the same three-factor structure (Watson, Clark, & Harkness, 1994).

Moreover, work by Rothbart and colleagues with children has shown that a similar model emerges by toddlerhood. Their three-factor model of temperament consists of Surgency/Extraversion, Neuroticism/Negative Affectivity, and Effortful Control.

Surgency/Extraversion relates to Positive Emotionality/Temperament, Neuroticism/ Negative Affectivity to Negative Emotionality/Temperament, and Effortful Control to Disinhibition (vs. Constraint; Rothbart & Ahadi, 1994; Tellegen, 1985; Watson & Clark, 1993). These linkages provide additional evidence that there is a basic overall trait structure of temperament and personality that persists throughout the lifespan.

Work by Shiner and colleagues (2000; 2005; Shiner, Masten & Tellegen, 2002; Shiner, Masten, & Roberts, 2003) finds that taxonomies of temperament and trait-related symptoms in children and adolescents are precursors of adult personality dimensions. Participants in their longitudinal study included 205 third- through sixth-grade children who were followed up 10 (Shiner, 2000; Shiner et al., 2002) and 20 years later (Shiner et al., 2003). Results suggested that self-reported personality, measured by the Multidimensional Personality Questionnaire (MPQ), at ages 17 to 23 (mea*N* =20) years and 28 to 34 (mea*N* =30) years was significantly predicted by childhood personality, measured by outside sources such as parents, child interviewers, and teachers. A striking aspect of this continuity is that the patterns of associations between the childhood traits and age 30 personality largely mirrored the patterns of associations observed between the same childhood traits and age 20 personality. Further, the size of the cross-time correlations generally did not drop over time (Shiner et al., 2003). Additionally, at the 20 year follow-up, all of the childhood personality traits predicted at least one domain of competence (e.g., rule-abiding vs. antisocial conduct, friend relationships), even after controlling for IQ (Shiner et al., 2003). These studies add to the growing evidence that childhood personality influences later personality and adaptation, even after several decades of life.

Furthermore, temperament traits that have predictive relations with later behavior emerge as early as toddlerhood. Caspi, Moffitt, Newman, and Silva (1996) reported that children identified as undercontrolled at age 3 years were especially likely, at age 21 years, to have Antisocial Personality Disorder (ASPD), to be involved in crime, and to

have alcohol problems. In a 4-year longitudinal study of children from toddlerhood to early school age, Murray and Kochanska (2000) reported that low levels of effortful control related significantly to externalizing behavior problems. Similarly, Olson, Sameroff, Kerr, Lopez, and Wellman (2005) provided data in support of a link between effortful control and externalizing problems in 3-year-old children. The results of this study indicated that individual differences in effortful control were negatively associated with children's externalizing problems as reported by mothers, fathers, and teachers. Rubin, Burgess, Dwyer, and Hastings (2003) provide similar findings. Again, lower levels of effortful control at age 2 were accompanied by higher levels of externalizing problems 2 years later at age 4 in a normative sample of toddlers. Importantly, this association remained significant after controlling for other cognitive factors, such as IQ, and reactive temperament factors, such as emotionality.

Additionally, several recent studies of the link between externalizing disorders and personality have used this hierarchical three-factor model of temperament. Using data from the Minnesota Twin Family Study (MTFS), Krueger et al. (2002) found support for a hierarchical model linking disinhibitory personality traits to substance dependence and antisocial behavior indicating an etiological link with externalizing disorders. Consistent with these findings, Krueger, McGue, and Iacono (2001) examined the higher order structure of common mental disorders in a community sample of men and women in the MTFS. They found an externalizing psychopathology factor was associated consistently across gender with lower Constraint scores. Although the MTFS research did not examine ADHD, when Lahey and colleagues (Lahey et al., 2004) included ADHD in their diagnostic structural analyses, it also loaded on an externalizing factor.

In a review of studies using the Tridimensional Personality Questionnaire (TPQ), Howard, Kivlahan, and Walker (1997) found that the TPQ Novelty-Seeking scale, an indicator of behavioral disinhibition, consistently predicted externalizing disorders, such

as early onset alcohol abuse and criminality. The authors also found that this scale effectively discriminated alcoholics exhibiting antisocial behavior from those that do not.

Other research has documented correlations between certain temperament styles and conduct problems in school-aged children and as adolescents (Caspi, Moffitt, Silva, Stouthamer-Loeber, Schmutte, & Krueger, 1994). Caspi et al. (1994) examined relations between personality traits and delinquency in two different samples: 18–year-old males and females in New Zealand, and a diverse group of 12- and 13-year old boys in Pittsburgh. In both samples, they used the Multidimensional Personality Questionnaire (MPQ), which assesses 11 lower order or primary scales that comprise the Big Three.[1] Results suggested robust personality correlates of delinquency in different nations and age cohorts, as well as across gender and race. Greater delinquency was associated with high Negative Emotionality and low Constraint, the opposite pole from Disinhibition. The authors concluded that high Negative Emotionality accompanied by low Constraint is a strong predictor of antisocial behaviors.

Additionally, in their New Zealand study, these authors tested the continuity hypothesis that temperamental variations in early childhood predict personality differences in later life. In particular, they found that children who were undercontrolled at age 3 had elevated scores at age 18 on MPQ Negative Emotionality and very low scores on MPQ Constraint (Caspi & Silva, 1995). This is the same personality profile that Caspi et al. (1994) found linked to delinquency.

Personality factors associated with CD also have been studied by a number of investigators. Krueger et al. (1994) found that high Negative Emotionality and low Constraint were significant predictors of antisocial behavior. In a study comparing severely conduct-disordered, incarcerated adolescents ranging in age from 14 to 20 years

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[1] Tellegen and colleagues (Patrick, Curtin, & Tellegen, 2002) now separate his Extraversion/Positive Emotionality factor into “Agentic “ and “Communal” Positive Emotionality, with the former marked by Social Potency and the latter by Social Closeness.

with a normal community sample, Daderman (1999) also found more than two standard deviation differences between groups on Eysenck's Psychoticism and Impulsiveness (recall that, despite its label, Psychoticism is a measure of Disinhibition). In a longitudinal Canadian study of over 800 French-speaking boys ages 11 to 17 years, Carrasco, Barker, Tremblay, and Vitaro (2006) found that for boys following the most persistent trajectory in physical aggression, theft, and vandalism, the most important personality dimension was Psychoticism. Similarly, in a study of CD boys between the ages of 16 and 20 years, Tranah, Harnett, and Yule (1998) found the CD boys had significantly higher scores on Psychoticism and Impulsivity as compared to an age and IQ matched control group. These authors concluded that in terms of personality traits, Impulsiveness and Psychoticism appear to be most useful in differentiating CD and normal samples.

More recently, Cukrowicz, Taylor, Schatschneider, and Iacono (2006) examined personality patterns in a large sample of twins between the ages of 11 and 17 years in the MTFS. They showed an association of a personality profile consisting of high Negative Emotionality and low Constraint with CD, ADHD, and the comorbid CD-ADHD condition. The group with comorbid CD-ADHD also had the most extreme personality profile, regardless of gender and developmental period. The CD only and ADHD only groups did not differ significantly in their personality profiles, but both differed from the control group. The authors asserted that their data suggest that the association between personality traits and the expression of externalizing disorders may represent a "dose effect" of personality. That is, lower Constraint coupled with higher Negative Emotionality is associated with a singular presentation of CD or ADHD, and greater extremity on these dimensions increases the likelihood of their comorbidity CD-ADHD.

As mentioned previously, genetic influences on disinhibition may help to explain associations between externalizing psychopathology and personality. Behavioral genetic research supports a substantial genetic contribution to many dimensions related to

behavioral disinhibition, including childhood externalizing psychopathology, antisocial behavior, and the personality dimension of Constraint versus Disinhibition (Iacono, Carlson, Taylor, Elkins, & McGue, 1999).

Behavioral genetics studies also provide strong evidence that ADHD has a substantial genetic component (Doyle, Faraone, Seidman, Wilcutt, Nigg, & Waldman, 2005). Heritability estimates from twin and adoption studies are consistently high, with additive genetic effects accounting for as much as 80% of the variance in underlying susceptibility (Thapar, Holmes, Poulton, & Harrington, 1999). Additionally, there is a substantial genetic influence on individual differences in adult antisocial behavior and criminality and the heritability of constraint has been estimated to be 50 % (Billig, Hershberger, Iacono, & McGue, 1996; Tellegen, Lykken, Bouchard, Wilcox, Segal, & Rich, 1988).

Psychobiological Models

Gray (1970, 1991; Gray & McNaughton, 2000) described three basic brain systems associated with temperament that are relevant for understanding behavior in response to salient environmental stimuli. His seminal work provided a theoretical basis for early models of the Big Three. The behavioral inhibition system (BIS), which serves to alert an individual to the possibility of danger or punishment, is part of the septo-hippocampal system (SHS) and has projections to the prefrontal cortex. The prefrontal cortex is hypothesized to prepare and control motor plans and to feed this information back to the SHS. BIS activity is responsible for feelings of anxiety and incites the individual to stop ongoing action and to scan the environment for further cues concerning how best to behave.

The behavioral approach system (BAS) is sensitive to signals of reward and is involved in approach behavior. Depue uses the term behavioral facilitation system (BFS) for his almost identical system, and his work (Depue & Collins, 1999; Depue & Iacono, 1989; Depue & Lenzenweger, 2001) provides strong support for Gray's BAS. Depue and

colleagues have provided extensive data supporting the role of the mesolimbic dopamine system in mediating incentive effects of conditioned stimuli for reward. Finally, the fight/flight system is sensitive to conditioned, aversive stimuli. Gray (1991; Gray & McNaughton, 2000) has hypothesized that differences in the reactivity of these three systems determine differences in temperament.

Gray (1982) also posits a decision mechanism, the comparator, which determines the relative weighting of stimuli for the BAS and BIS. The comparator serves either to allow the BAS to continue the ongoing behavior or triggers the BIS to inhibit behavior in order to weigh possible outcomes. Gray's comparator resembles the behavioral inhibition system in Barkley's (1997) theory of ADHD. Barkley (1997) describes an inhibitory system that pauses approach behavior to allow EFs to weigh possible responses, determine the most desired consequence, and then activate behavior in service of that determination. In both Gray and Barkley's models, it is this system that appears to be malfunctioning when approach-dominant behaviors, such as many externalizing behaviors, occur.

In terms of externalizing behaviors, Gray noted that persistent antisocial behavior implies a weak BIS, reflected in an insensitivity to punishment, combined with a normal or strong BAS (Gray, 1970). Deficiencies in these neural systems have been suggested subsequently as the source for externalizing behaviors in both adults (Fowles, 1980) and children (Quay, 1993). Similarly, other theories suggest that overly strong tendencies to approach novel and/or dangerous situations, that is, a dominance of the BAS reward system over the BIS, may place an individual at risk for developing significant externalizing behavior problems (Fowles, 1988; Quay, 1993). This imbalance of the BIS and BAS/BFS reduces the potential for avoidance conditioning to socialization stimuli.

Depue and Lenzenweger (2001) suggest that a strong, overactive BAS/BFS may result from high levels of dopamine (DA) in the mesolimbic system. Additionally, according to Depue's threshold model, a strong BFS requires less incentive value to

activate behavior. Activation of appetitive behavior gives incentive value to cues and strengthens the DA-based BFS. Thus, experience appears to affect DA reactivity and therefore BFS strength. Through interaction with the environment, therefore, an already strong BFS may be strengthened further. Depue's model further posits that low serotonin, which has been associated with N/NE (Siever & Davis, 1991; Watson & Clark, 1993) as well as externalizing behaviors (Moore, Scarpa, & Raine, 2002), facilitates DA activity by reducing its threshold for activation. This, in turn, results in an exaggerated response to incentive stimuli that is most apparent in approach-avoidance conflicts. The approach-dominant state produced by high levels of DA places greater weight on immediate versus distal rewards. This approach-dominant state leads to greater attempts to experience increased magnitude and frequency of incentive reward, which are manifested as impulsive behaviors. Depue and colleagues have related approach-dominance to the personality trait of nonaffective Constraint (vs. Disinhibition; Depue & Lenzenweger, 2001).

Dopamine is integral to the development and functioning of the prefrontal cortex, and is more concentrated in the prefrontal cortex than in any other cortical region (Pihl & Benkelfat, 2005). In support of the role that DA plays in the prefrontal cortex in disinhibition, Brown and Goldman (1977) showed that as infant monkeys improved their performance on a delayed response task requiring inhibition, the DA level in the prefrontal cortex increased, as did the density of DA receptors.

As discussed by Rothbart and Bates (1998) in the child literature and by Watson and Clark (1993) in the adult literature, a complete temperament model consists not only of affective systems, but also contains a regulatory temperament factor. In the three-factor model of temperament, this dimension is labeled Disinhibition (vs. Constraint) and may be similar to Gray's (1982) comparator or Barkley's (1997) behavioral inhibition. Individual differences, in Disinhibition (vs. Constraint) for example, predispose youth

toward externalizing disorders early in life and are related to the persistence of these behaviors (Caspi et al., 1995; Krueger et al., 1994).

In relation to Big Three temperament traits, Negative Affectivity is generally seen as corresponding to the BIS, and Positive Affectivity is parallel to the BAS. Incorporating both the assertion that the BIS is related to Negative Affectivity, and Fowles' (1980; 1988) assertion that the BIS is more related to Disinhibition, it may be that the BIS, in fact, relates to both Negative Affectivity and Disinihibition. The comparator, which according to Gray's model is located within the septohippocampal BIS, appears to act as an inhibitory system, which is consistent with Barkley (1997), while the rest of the BIS appears to correspond to Negative Affectivity. It also may be that the BIS actually corresponds to Digman's (1997) Alpha, which encompasses both Disinhibition via FFM Agreeableness and Conscientiousness as well as Negative Affectivity (Markon et al., 2005).

Neuroscience of Externalizing Behaviors

Nigg (2000) asserted that it is important to consider neural systems within which particular inhibitory processes may be implemented. The search for neural substrates of externalizing behaviors has a long history that began with clinical observations of patients with brain lesions. The most famous early example is Phineas Gage, who suffered an injury to the ventromedial and orbitofrontal cortex, after which he began to exhibit a marked change in personality and externalizing psychopathology (Damasio, Grabowski, Frank, Galaburda, & Damasio, 1994).

More recently, several case studies describe a high incidence of externalizing behavior in adults who suffered from lesions to the frontal cortex before the age of 8 years (Anderson, Bechara, Damasio, Tranel, & Damasio, 1999; Anderson, Damasio, Tranel, & Damasio, 2000; Eslinger, Grattan, Damasio, & Damasio, 1992). Anderson et al. (1999; 2000) report data from two adults concerning the long-term consequences of early (before 16 months) prefrontal cortex lesions. As when damage occurs in adulthood,

the two early onset patients bore considerable similarity to patients with CD or antisocial personality disorder, namely exhibition of externalizing behaviors and a disinhibited personality.

Similarly, Eslinger et al. (1992) described an adult patient who sustained damage to her frontal lobes as a child and exhibited deficits in social behavior characterized by externalizing symptoms. She also showed neuropsychological deficits in higher cognition (i.e., executive functions), most notably in self-regulation of emotion and affect. Similar observations have been noted in larger samples as well. Grafman, Schwab, Warden, Pridgen, Brown, and Salazar, (1996) found higher aggressive and violent "attitudes" in a sample of Vietnam War veterans who suffered frontal cortex injuries, specifically in the orbitofrontal cortex, as compared to a normal control group and a group with lesions to other brain sites. Based on such research, implicating the frontal lobes as mediating the loosely defined set of abilities that have been termed executive functions (discussed subsequently; see also Tranel, Anderson, & Benton, 1994) is appropriate.

Because such examples are so prevalent, several hypotheses of the role of the frontal cortex in behavior regulation have been developed. The "somatic marker hypothesis" suggests that ventromedial frontal lobe lesions impair individuals' ability to recognize and consider emotions when making a decision (Damasio, 1996; Damasio, Tranel, & Damasio, 1991), resulting in a syndrome called "acquired sociopathy" (Damasio, 2000; Damasio, Tranel, & Damasio, 1991). Whatever the mechanism may be, when considered together, lesion studies such as these suggest that an intact frontal cortex is important for adequate control of externalizing behaviors.

Another approach to studying the neural underpinnings of aggressive behavior is imaging brains of individuals with symptoms of externalizing disorders. Similar to the literature on brain lesion patients, studies using structural magnetic imaging find deficits in prefrontal cortex functioning in individuals exhibiting various forms of externalizing behaviors. For example, Raine, Lencz, Bihrle, LaCasse, and Colletti (2000) found an

11% reduction in grey-matter volume in the orbitofrontal cortex in a sample of individuals with antisocial personality disorder as compared to two different control groups. Additionally, using functional imaging, Raine, Buchsaum, and LaCasse (1997) described hypometabolism in the prefrontal cortex in a sample of individuals charged with murder or manslaughter. A comprehensive review of the literature examining the link between frontal lobe dysfunction and violent criminal behavior found that clinically significant focal frontal lobe dysfunction was clearly associated with aggressive behaviors (Brower & Price, 2001).

Executive Functions

Similar to temperament, neurocognitive impairments may be a key route through which genetic and psychosocial influences on antisocial behavior are expressed (Raine, Moffitt, Caspi, Loeber, Stouthamer-Loeber, & Lynam, 2005). EF has become an umbrella term for higher order cognitive capacities that encompasses a number of subdomains, including judgment, decision making, planning, and social conduct (Baron, 2004; Tranel et al., 1994). Good EF requires the ability to plan and sequence complex behaviors, simultaneously attend to multiple sources of information, grasp the gist of complex situations, resist distraction and interference, inhibit inappropriate responses, and sustain behavior for prolonged periods (Baron, 2004; Denckla, 1989).

Similar to the extensive literature relating temperament to externalizing behaviors, numerous authors have found that neuropsychological deficits, specifically deficits in higher order functioning (i.e., EF), are an important correlate or risk factor for externalizing behaviors such as aggression (Morgan & Lilienfeld, 2000; Moffitt, Lynam, & Silva, 1994; Nigg & Huang-Pollack, 2003), conduct problems (Seguin, Nagin, Assaad, & Tremblay, 2004) and ADHD (Barkely, 1997; Nigg, 2001; Seargent, Geurts, Huijbregts, Scheres, & Oosterlaan, 2003). The latter is consistent with the findings, discussed earlier, that ADHD, aggression, and conduct problems all fall under the superfactor of externalizing behaviors (Krueger et al., 2005). Further, poor EF has been

linked to early onset of both aggression and hyperactivity-related problems (Barkley, 1997; Moffitt et al., 1994), and Seguin & Zelazo (2005) proposed that marked developmental increases in children's EF are responsible for declines in externalizing behaviors. In cases where children's level of externalizing behaviors remain high, the development of the prefrontal cortex and, therefore, of EF is atypical (Nagin & Tremblay, 1999; Tremblay et al., 2004).

Relatedly, a growing neuropsychological literature has found consistently that externalizing participants, often characterized as antisocial and violent, have neuropsychological impairments (Henry & Moffitt, 1997; Ishikawa & Raine, 2002; Moffitt, 1993; Morgan & Lilienfeld, 2000). In an early quantitative review of the literature, Pennington and Ozonoff (1996) found no relation between CD and EF, and concluded that comorbid ADHD most likely accounted for deficits in frontal EF often believed to be linked with adolescent CD. However, they did not limit their review to well-validated measures of EF. Counter to Pennington and Ozonoff (1996) and more consistent with the newest literature, Morgan and Lilienfeld's (2000) comprehensive meta-analysis of studies using well-validated EF measures indicated a robust and statistically significant relation between antisocial behavior and EF deficits. Neither age, sex, ethnicity, nor intelligence moderated the relation between antisocial behavior and EF.

Moffit and Lynam (1994) identified neuropsychological deficits associated with early onset CD and delinquency. They found that low verbal IQ and executive dysfunction were associated with a subgroup whose behavior problems were most serious and persistent. They concluded that the effects of early neuropsychological vulnerabilities are amplified over time as children interact with their environments due, in part, to the neuropsychological problems rendering children more vulnerable to pathogenic environments.

A recent investigation, using data from the Pittsburgh Youth Study, a longitudinal study of the development of antisocial behavior, examined neurocognitive impairments in boys on childhood-limited, adolescent-limited, and life-course-persistent antisocial paths as compared to a group of controls (Raine et al., 2005). They found both spatial and memory function impairments in those on the life-course-persistent as well as the child-limited antisocial path, independent of abuse, psychosocial adversary, or head injury. These impairments were in contrast to intact functioning in those on the adolescent-limited path and those in the control group. It appears from these data that the early onset children are neuropsychologically distinct from the other groups.

Nigg and Huang-Pollack (2003) found EF weakness to be associated with externalizing behavior problems, independent of intelligence, reading ability, sex, or earlier behavior problems. Nigg, Quamma, Greenberg, and Kusche (1999) found this association with teacher-rated externalizing behavior problems in childhood, whereas Moffitt and Henry (1989) also found it in cross-sectional data examining self-reported delinquency in adolescence. Across studies, however, evidence for executive deficits among CD samples is clearest in children with comorbid attentional problems or ADHD (Moffitt & Henry, 1989; Moffitt & Silva, 1988; Pennington & Ozonoff, 1996), consistent with Lynam's (1996; 1998) assertions.

Moffitt, Lynam, and Silva (1994) reported longitudinal evidence from their New Zealand study that prospective measures of neuropsychological status predicted antisocial outcomes 5 years later. Moffitt et al. (1994) administered a battery of EF measures (e.g., the Rey Auditory Verbal Learning Test, Trail Making Test, and the Wisconsin Card Sort Test) when participants were 13 years old. At age 18, they collected data on externalizing behaviors, including court convictions, police contacts, and self-reported delinquency. Results indicated that poor neuropsychological scores were associated with early onset delinquency and persistence of such behaviors thereafter.

In a cross-sectional assessment of preschool children, Cole, Usher, and Cargo (1993) demonstrated that difficulties in EF, as measured by rapid alternating stimulus naming, block sort, and visual search tasks, were positively associated with young children's ability to control disruptive behavior. Similarly, Speltz, DeKlyen, Calderon, Greenberg, and Fisher (1999) examined neuropsychological profiles of clinic-referred preschool boys who met criteria for Oppositional Defiant Disorder (ODD) with and without comorbid ADHD. They compared these boys to a sample of peers without behavior problems. Compared to the normative sample, clinic-referred boys had lower performance on tests measuring EF, specifically motor planning and verbal fluency. Additionally, boys with comorbid ODD and ADHD performed less well than those with only ODD, suggesting there may be a "dose effect" of neuropsychological deficits, as well as disinhibition, on externalizing behaviors.

In a sample of 6-to-9 year-old children, Riggs, Blair, and Greenberg (2003) examined associations between two aspects of children's EF--inhibitory control as measured by the Stroop Test and sequencing ability as measured by the Trail Making Test--and parent-and teacher-rated behavior. Inhibitory control significantly predicted change in both parent- and teacher-reported externalizing behavior over a 2-year period. Additionally, sequencing ability significantly predicted change in teacher-reported externalizing behavior over a 2-year period. Taken together, these results provide additional evidence for the role of EF in predicting change in level of externalizing problems. These authors conclude, as others have, that neuropsychological deficits may place young children at risk for developing behavior problems.

In a sample of CD adolescents, Lueger and Gill (1990) examined what they referred to as "frontal lobe cerebral impairment" via measures related to frontal lobe functions as compared to matched controls. Using neuropsychological measures such as the Wisconsin Card Sorting Test, the Trail Making Test, and the Auditory Verbal Learning Test, these authors found that adolescents with diagnosed CD manifested cognitive

impairments characteristic of frontal lobe dysfunction in adults with brain damage. Perseveration, failure to use feedback to correct responses, sequential memory errors, and lower recall rates characterized CD adolescents even when the effects of age and verbal intelligence were controlled.

In a 2-year longitudinal study, Nigg and colleagues (1999) examined associations between a selected subset of commonly used clinical neuropsychological measures and later behavioral adjustment in early to middle childhood. Examining inhibitory control using the Trail Making Test and the Stroop Color-Word Interference Test, results suggested that neuropsychological functioning at Time 1 significantly contributed to the prediction of behavioral outcome at Time 3, even after partialling out Time 1 behavior. The authors concluded that inhibitory control is important to externalizing behavior, consistent with many theories relating externalizing behavior to the failure of regulatory mechanisms.

Similar to Disinhibition, it is clear from the neuropsychological literature that factors related to problems in EF are also highly related to externalizing behaviors, and appear to provide an additional etiological risk factor associated with the development and persistence of externalizing behaviors.

Temperament-Executive Functions Relations

It is important to note that neural systems are not viewed as a reductionistic substitute for psychological processes (Miller, 1996). Performance on neuropsychological measures may be multiply determined and reflect either, or both, personality variables and neuropsychological deficits (Lilienfeld, 1992; Nigg, 2000). The lack of integration of personality and neuropsychological models limits clinical research and stymies progress (Nigg, 2000). As many of these personality variables are themselves subserved by the frontal lobes, the distinction between personality and neuropsychological models of disinhibition may be an artificial. As such, temperament approaches may represent

simply a different level of analysis of the same regulatory system studied via neuropsychological assessments (Nigg, 2000).

Few studies in the adult literature report data on relations between trait temperament measures of disinhibition or impulsivity and neuropsychological measures of EF (Casillas, 2005; Ready, Stierman, & Paulsen, 2001). In a study aimed at examining the ecological validity of neuropsychological measures and self-report personality measures of EF-related behaviors, Ready et al. (2001) found only one significant correlation ($p < .05$) between the Wisconsin-Card-Sorting Test's Failure-to-Maintain-Set score and a Disinhibition scale ($r = .29$). In terms of each approach's ability to predict behaviors, neuropsychological measures predicted work-related behaviors and personality measures predicted substance use, risk taking, and aggressive behaviors. Casillas (2005) reported similar findings in terms of relations between neuropsychological measures and personality measures. He found no more than a near-chance proportion of correlations statistically significant in his dataset consisting of both traditional neuropsychological measures and personality measures of Disinhibition and Impulsivity.

Logan, Schachar, and Tannock (1997) provided more promising data concerning the relationship between impulsivity and reaction time on the stop signal paradigm. They found significant correlations between reaction time and Impulsivity as measured by the Eysenck Personality Inventory. These findings highlight the importance of including personality assessment in standard neuropsychological assessment, which is the approach taken in the proposed study.

Using data from the Pittsburgh Youth Study, White et al. (1994) examined relations between measures of impulsivity in a multisource, multimethod battery of measures in a sample of more than 400 adolescents. Measures included both traditional EF tasks such as the Continuous Performance Test, the Stroop-Word Association Test, and Trail Making Test, and personality measures such as the Eysenck Impulsiveness Scale and the

California Child Q-Set. When subjected to factor analysis, measures of EF loaded on one factor whereas personality data loaded on another. Few EF tasks correlated with personality ratings and of those that did, none correlated above .22.

Only a few studies report data on relations among all three domains--trait measures of temperament, neuropsychological measures of EF, and externalizing behaviors (Giancola, Mezzich, & Tarter, 1998; Giancola, Roth, & Parrott, 2006; Martel, et al., 2007). Giancola et al. (1998) assessed whether EF difficulties and a difficult temperament are related to aggressive and nonaggressive forms of antisocial behavior in a sample of 249 CD females and controls between the ages of 14 and 18 years. They submitted their seven EF tasks–including three subtests from the Wechsler intelligence tests, and four neuropsychological tasks such as the Stroop Color-Word Interference Test--to a principal components analysis which yielded a single common factor, which was used for all analyses. A difficult temperament index was created by summing all ten subscale scores of the Dimensions of Temperament Survey-Revised (Windle & Lerner, 1988) which likewise was used for all analyses. Correlations between the EF dimension, the difficult-temperament index, and both nonaggressive and aggressive antisocial behavior were moderate (.26-.32). Additionally, the CD group exhibited significantly poorer performance on the EF variable and a significantly greater difficult-temperament index as compared with the control group. Results also indicated that the combined influence of low EF capacity and difficult temperament related significantly to both aggressive and nonaggressive antisocial behavior, even after controlling for age, SES, ADHD, and the Vocabulary subtest of the Wechsler intelligence test most appropriate for the participants' age. In this sample of female adolescents, these results demonstrate that although EF and temperament are moderately related, both contribute incremental variance above the other in relation to externalizing behaviors.

Given that this is the only study to have tested these relations using a sample of diagnosed adolescent girls, Giancola et al. (2006) conducted a follow-up study aimed at

better determining the relations among EF, difficult temperament and aggression in a large sample of young men and women. Using a similar battery to that used by Giancola et al. (1998), these researchers also used an aggregated difficult temperament index and a single EF factor. Results indicated that EF mediated the relation between difficult temperament and self-reported aggression, consistent with findings from the Giancola et al. (1998) study. This model, however, held only for men. The authors suggest that this gender difference may be due to the lower rates of aggression reported by the women in the study.

More recently, in a sample of high risk adolescents, Martel et al. (2007) examined the joint contribution of the personality domains of resiliency and reactive control and a neuropsychological battery of EF measures to adolescent internalizing and externalizing behaviors, as well as academic and social competence using a longitudinal design in a sample of 498 adolescents. Adolescents' personality was assessed via the California Q-sort completed by a test administrator after spending a day with the adolescent. Two traits were examined: resiliency, related to the flexible mechanisms aimed at coping with and thoughtfully adjusting to the environment; and reactive control, a form of regulation motivated by immediate incentive and related (negatively) to behavioral impulsivity. The EF battery used in the Martel et al. study is highly similar to that of the current proposal and consisted of the Wisconsin Card Sorting Test, the Stopping Task, the Controlled Oral Word Association Task, the Stroop Color-Word Interference Test, the Tower of Hanoi, and the Symbol-Digit Modalities Test. Similar to Giancola et al. (1998, 2006), Martel et al. conducted a principal components analysis of the 10 neuropsychological scores; however, they extracted four factors, which they then used for subsequent analyses and found low but significant correlations (average=.17) between resiliency and the working memory/set-shifting, response inhibition, and naming speed factors of the EF battery. In contrast, reactive control was found to be associated only with the interference control factor. Additionally, when they examined the joint contribution of both domains to

behavior problems, they found both personality and EF related to the development of problem behavior. Specifically, poor response inhibition and weak reactive control contributed to the development of externalizing problems.

Taken together, these results suggest that selected self- and other-report temperament dimensions and well-chosen neuropsychological measures may be linked, possibly through partial overlap that is, both being under at least partial control of the prefrontal cortex (Nigg, 2000). The current study aimed to examine these relations using a trait measure of temperament, well-validated neuropsychological measures of EF, and a dimensional approach to conceptualizing externalizing behaviors.

Current Study

Results such as those reviewed above provide a strong grounding for the current study aimed at examining relations among more refined EF constructs, more empirically valid temperament traits, and a better defined dimension of externalizing examining both rule-breaking behavior and aggression, in a broader, more inclusive sample of youth. As indices of presumed brain function, neither neuropsychological scores nor temperament traits are sufficient by themselves as a comprehensive developmental model of externalizing behaviors. Substantial empirical literatures link EF and temperament, respectively, to externalizing behaviors, but they rarely have been considered jointly. The proposed study examines interrelations among these three domains empirically.

Although a small number of previous empirical studies have examined interrelations among these three domains, none have done so in a way that enables tests of a comprehensive theory incorporating the most current research in both the child and adult literatures. The present investigation proposes to improve upon previous work by examining the triangular relations among higher order temperament traits, well validated neuropsychological measures of EF, and a dimensional approach to externalizing behaviors in a sample of youth ages 11 to 16 years. As males are more likely to exhibit greater variance in externalizing behaviors than females, data collection resources were

focused on males. Although a causal model cannot be tested due to the lack of a longitudinal component, the proposed study will be able to suggest whether it might be fruitful to conduct an intensive longitudinal study. It should be noted that the current study aims to examine a structural model, because the cross-sectional design of the current study and the focus on phenotypic manifestations (vs. underlying mechanisms) preclude examination of a process or etiological model.

Current Study Hypotheses

Based on the extant literature, it is hypothesized that both temperamental Disinhibition and Negative Temperament (NT) will be associated with rule-breaking behavior, aggression, as well as the composite externalizing scores. It is expected that Disinhibition will evidence stronger associations with all three outcomes than will NT. Further, it is hypothesized that NT will evidence stronger associations with aggression than it will with rule-breaking behavior. In two independent samples of college students, work by Burt and Donnellan (2008) suggests that the link between disinhibition (vs. constraint) and antisocial behavior is largely a function of rule-breaking behaviors, with aggression uniquely associated with negative emotionality (Burt & Donnellan, 2008).

Although the structure of EF has historically been difficult to elucidate, recent factor analytic work has shown convergent evidence of both unity and disunity in EF (Miyake et al., 2000; Latzman & Markon, under review; Lehto, Juujarvi, Kooistra, & Pulkkinen, 2003). That is, EF consists of a central executive with diverse functions. Additionally, these investigations suggest that EF may best be conceptualized as consisting of three separable, yet related, dimensions. These dimensions emerge across investigations, even when disparate EF batteries are utilized. In a recent investigation of the factor structure of the Delis-Kaplan Executive Function System (D-KEFS), the neuropsychological battery employed in the current study, Latzman and Markon (under review) termed these three EF dimensions Conceptual Flexibility, Monitoring, and Inhibition. Conceptual Flexibility relates to one's ability to generally engage in flexible

thinking and behavior. Monitoring relates to abilities to actively monitor and evaluate information in working memory. Inhibition concerns the ability to deliberately inhibit a dominant or automatic response.

As such, EF hypotheses will be based on these three dimensions. Significant relations between EF and temperament are expected. Specifically, consistent with theoretical assertions (Nigg, 1999), it is expected that neuropsychological Inhibition and Conceptual Flexibility will be negatively associated with temperamental Disinhibition. No a priori hypotheses are made for relations between Monitoring and temperament.

Because these three dimensions of EF have not yet been examined in relation to externalizing, a priori hypotheses are based on the literature regardingneuropsychological tasks that anchor each of these dimensions. Conceptual Flexibility is anchored by Conditions 1 and 2 of the D-KEFS Sorting Test, a card sorting test similar to the Wisconsin Card Sorting Test (WCST), which was found to have an effect size (Cohen's *d*) of .24 with antisocial behavior in Morgan and Lilienfeld's (2000) meta-analysis. Additionally, Condition 2 has similar demands to the Category Test, found to have an effect size of .37 with antisocial behavior (Morgan & Lilienfeld, 2000). Therefore, it is hypothesized that Conceptual Flexibility will be negatively associated with externalizing behaviors. The D-KEFS Technical Manual (Delis et al., 2001b) reports correlations between the WCST Perseverative Errors and Conditions 1 and 2 of the Sorting Test of -.40 and -.35, respectively, providing additional support for these hypothesized relations.

Inhibition is anchored by the Trail Making Test and the Color-Word Test, an analogous test to the Stroop Interference Test. Again, based on effect sizes reported by Morgan and Lilienfeld (2000), it is hypothesized that Inhibition will also be negatively associated with externalizing behaviors. Specifically, Morgan and Lilienfeld (2000) report effect sizes of .33 and .43 for relations between aggression and the Trail Making Test and the Stroop Interference Test, respectively

The category switching tasks on the D-KEFS that anchor the dimension of Monitoring, Verbal Fluency Conditions 3 and 4, have yet to be examined in relation to externalizing behaviors. While the Morgan and Lilienfeld (2000) meta-analysis found verbal fluency to have an effect size of .33 with antisocial behavior, the switching component of the tasks that anchor Monitoring have been shown to be relatively distinct from production activities (Rende, Ramsberger, & Miyake, 2002). As such, no a priori hypotheses regarding relations between this dimension of EF and externalizing are made.

Because it is hypothesized that the relations between temperament and EF will be small and that both will be associated with externalizing, it is hypothesized that EF will contribute incremental variance in the prediction of externalizing and will provide unique contributions in explaining externalizing at both the manifest and latent variable level. Specifically, based on the extant literature (Morgan & Lilienfeld, 2000), it is hypothesized that the EF dimensions of Conceptual Flexibility and Inhibition will provide incremental variance.

METHODS

Participants

A broad-based sampling strategy was used to accrue a heterogeneous sample of 175 male youth, and their mothers, representative of youth with and without externalizing behavior problems. Youth had a mean age of 13.6 (*SD*=1.4) years and were 89% White. Families had a relatively high socioeconomic status, assessed by education and income. Most mothers had completed college or post-graduate education (71.9%), and one-third had an annual family income above $100,000 (ranging from under $15,000). See Table 1 for complete demographic data for the sample. Participants were recruited from the child subject pool maintained in the Department of Psychology at the University of Iowa, as well as by fliers in the community or via an advertisement placed in the daily newsletter of the University of Iowa Hospitals and Clinics. Participants were screened via mother-report of the following exclusion criteria: mental retardation, autism spectrum disorder, neurological disorder, past head injury requiring hospitalization, life-threatening medical illness, having been held back a grade or diagnosed with a reading disorder.

The majority of families (79.9%) were recruited from the child subject pool. Four youth did not complete at least one measure yielding unequal sample sizes across analyses. Three of these youth did not complete the personality assessment and one youth was color-blind and was therefore not able to be administered one of the EF subtests. One family withdrew from the study following their laboratory session resulting in a final sample of 174 male youth and their mothers.

Upon arrival in the laboratory, participants provided informed assent (youth) or consent (mothers), prior to study participation. At the completion of the visit, all participants were compensated $25. In addition, mothers were compensated $5 or $10 for transportation and parking, depending on whether they were from within or outside the Iowa City area, respectively.

Materials

Schedule for Nonadaptive and Adaptive Personality

—Youth (SNAP-Y)

All youth participants completed a computer administration of the Schedule for Nonadaptive and Adaptive Personality-Youth Version (SNAP-Y; Linde, Clark, & Simms, unpublished manuscript). The SNAP-Y is an item-level modification for youth of the SNAP-2. It thus assesses the same 15 personality dimensions and six response validity indices as the SNAP-2. The SNAP-Y scales are internally consistent: scale internal consistency reliabilities had a median value of .83 in a sample of 366 adolescents ranging in age from 12-18, and also demonstrate good convergent and discriminant validity with other self-report measures of personality (Linde et al., unpublished manuscript).

Schedule for Nonadaptive and Adaptive Personality

—Other Report Form (SNAP-ORF)

As evidenced by the consistency of findings across informants, using different measures, Cukrowicz et al. (2006) and both Harlan and Clark (1999) and Linde, 2001, provide data indicating that youths' parents provide useful information about their child's personality. Therefore, to assess further each youth's temperament, parents completed a computerized administration of the Schedule for Nonadaptive and Adaptive Personality-Other Report Form (SNAP-ORF; Harlan & Clark, 1999).

The SNAP-ORF is an alternate-format version of the SNAP consisting of 33 items, each comprised of two brief paragraph-like descriptions of the subcomponents of the 15 scales, one each describing the high and low ends of the dimensions, respectively, with each scale represented by one to three items. SNAP scale-level content and factor analyses were used to determine the subscales. Respondents are instructed to rate targets' usual personality, that is, what targets are like most of the time, using a six-point Likert-type scale, ranging from Very Much Like the low end of the trait to Very Much Like the

high end of the trait. The SNAP-ORF format is highly similar to that of the Multidimensional Personality Rating (MPR) developed by the Minnesota Twin and Family Study (MTFS; Cukrowicz et al., 2006) based on Tellegen's Multimensional Personality Questionnaire (MPQ; Tellegen, in press), which has been shown to be useful in examining personality profiles of children who differ on their presentation of externalizing behaviors.

The SNAP-ORF has shown acceptable internal consistency across scales. When parents were asked to rate college-age children, the SNAP-ORF scales had a median coefficient alpha of .66 for fathers and .69 for mothers (average interitem *r*s = .44 and .47, respectively; Harlan & Clark, 1999). Similar reliabilities have been found when parents have rated the middle- and high-school age children; median α=.65; average interitem *r* = .44. Additionally, convergent validity coefficients for fathers' and mothers' SNAP-ORF scales were reasonably strong (median *r*=.47; Linde, 2001).

Delis-Kaplan Executive Functions System (D-KEFS)

The full Delis-Kaplan Executive Functions System (D-KEFS; Delis, Kaplan, & Kramer, 2001a) was administered to each youth participant. The D-KEFS provides a standardized assessment of EF in individuals between 8 and 89 years. The D-KEFS consists of various procedures and tasks that have demonstrated sensitivity in the detection of frontal-lobe dysfunction. It is the first set of EF tests co-normed on a large and representative national sample designed exclusively for the assessment of EF. Eight of the D-KEFS tests have been standardized and normed for use with children as young as 8 years: (1) Trail Making Test, which assesses attention, concentration, resistance to distraction, and cognitive flexibility; (2) Verbal Fluency Test, which requires speeded lexical production and automatic lexical access, and reflects efficient lexical organization; (3) Design Fluency Test, an established nonverbal task analogous to verbal fluency; (4) Color-Word Interference Test, which assesses selective or focused attention, the ability to shift from one perceptual set to another as test requirements change, and the

ability to inhibit inappropriate responding; (5) Sorting Test, a measure of conceptual flexibility, (6) Twenty Questions Test, which assesses strategic thinking; (7) Word Context Test, which assesses deductive reasoning, hypothesis testing, and flexibility of thinking by requiring participants to discern what is intended by a made-up word based on its use in a series of sentences; and (8) Tower Test, which assesses forward planning of a sequence of steps as the participant tries to move a pattern of discs efficiently from a start configuration to a goal configuration to match a target pattern. Most of these tests use a game-like format.

The D-KEFS was standardized on a nationally representative, stratified sample of 1750 non-clinical children, adolescents, and adults, ages 8 to 89 years. The sample had a minimum of 75 people in each of the age groups that were used to generate age-specific norms. A large number of validity studies have been conducted with various D-KEFS tests across a wide-range of clinical and non-clinical populations demonstrating the sensitivity of the D-KEFS to the assessment of executive functioning (see Delis, Kramer, Kaplan, & Holdnack, 2004 for a review). Regarding the reliability of the battery, while some reviewers have expressed concern (Baron, 2004; Schmidt, 2003) other reviewers (Homack, Lee, & Riccio, 2005; Shunk, Davis, & Dean, 2006) and the authors of the battery (Delis, et al., 2004) have been more positive arguing that D-KEFS scores evidence as good, if not better, internal consistency and test-retest reliability as other neuropsychological assessments (i.e., Wisconsin Card Sorting Test; Heaton et al., 1993).

Recent factor analytic work (Latzman & Markon, under review) has found that D-KEFS individual achievement scores comprise three domains: Conceptual Flexibility, Monitoring, and Inhibition. Conceptual Flexibility is reflected in all three scores from the Sorting Test: Free Sort, Free Sort Description, and Sort Recognition. Monitoring is reflected by the two Category Switching scores from the Verbal Fluency tests and the Twenty Questions Test. Lastly, Inhibition consists of the Inhibition and Inhibition/Switching scores from the Color-Word Test, in addition to the Trail Making

Test and Design Fluency Test. The remainder of the scores derived from the D-KEFS did not significantly load on one discrete factor and, therefore, were not included in the calculation of composite scores for each of the three EF dimensions, which were the mean of each participant's standard scores across the various tests that fall within each dimension. These three empirical-derived aspects of EF have been shown to be differentially associated with other outcomes of interest (e.g., academic achievement; Latzman, Elkovitch, Young, & Clark, in press).

Child Behavior Checklist (CBCL)

Each mother completed the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001), which obtains reports on children's competencies and behavioral/ emotional problems. Parents provide information on 118 items that describe specific behavioral and emotional problems, and two open-ended items for reporting additional problems. Parents rate their child for how true each item is now or within the past 6 months using the following scale: 0 = not true (as far as you know); 1 = somewhat or sometimes true; 2 = very true or often true. For the purpose of the current study, the Rule-Breaking Behavior and Aggressive Behavior syndrome scales were used. Consistent with scoring procedures of the CBCL (Achenbach & Rescorla, 2001), the global externalizing composite grouping of Externalizing (comprised of both the Rule-Breaking and Aggressive Behavior syndrome scales) was also used.

Youth Self-Report (YSR)

Youth completed the companion Youth Self-Report (YSR; Achenbach & Rescorla, 2001) form. Youth provide information on 112 items that describe specific behavioral and emotional problems. Youths rate themselves for how true each item is now or was within the past 6 months, using the same three-point response scale as the CBCL.

Consistent with the CBCL, for the purpose of the current study, the Rule-Breaking Behavior and Aggressive Behavior syndrome scales and the global Externalizing composite grouping were used.

Research Assistant Training

Research assistants (RAs) were trained in accordance with training guidelines of the Benton Neuropsychology Laboratory, located in the Department of Neurology at the University of Iowa Hospitals and Clinics. RAs were taught how to administer the D-KEFS during laboratory meetings devoted to training of their administration. RAs were trained on each individual test of the D-KEFS. First, they were shown how to administer the subtest and were given the opportunity to practice each step of the tests. RAs then observed two full assessments performed on volunteers (i.e., other lab members) and practiced on their own until they felt they were ready to be observed administering the tests. They then administered the entire D-KEFS to at least two volunteers under the supervision of the principal investigator (RDL). Feedback was provided and discussed during this administration and subsequent administrations until the amount of feedback needed was minimal to none. RAs then completed one or more administrations without receiving feedback until after the assessment(s). RAs were required to administer the battery error-free twice in succession prior to confirmation of competence at this stage.

During training, all youth participants were assessed by the primary investigator with RAs observing whenever possible. Multiple observations were the norm, and observing *at least* one assessment of a research participant was required. Once RAs felt ready, and the PI agreed, they were required to conduct assessments of research participants under the supervision of the PI until two consecutive error-free assessments were completed, at which point the RA was deemed competent and certified to assess future participants without supervision. The PI observed approximately 20% of future administrations selected at random to ensure that competency is maintained. See Appendix B for RA Training Schedule.

Analytic Strategy

Analyses were conducted in six steps and involved examination of: (1) associations among the youth self-reported temperament and behavioral instruments and

among the mother-reported temperament and behavioral instruments; (2) relations between key demographic variables and dependent variables, results of which were then used to modify subsequent multivariate analyses as indicated (3) agreement between youth- and mother-reported temperament and behavior; (4) associations among youth- and mother-reported temperament, externalizing behavior, and EF; (5) the incremental variance explained by EF above and beyond temperament in the prediction of externalizing behaviors (the composite score as well as the separate rule-breaking behavior, aggression scores); and (6) the unique contributions of temperament and EF in explaining externalizing behaviors.

Associations Between Temperament and Externalizing Behaviors

Associations between temperament and behavior were examined to test hypotheses that Disinhibition, Negative Temperament, and related specific traits, would be associated significantly with externalizing behaviors. Analyses of associations among same-informant temperament and behavioral instruments provide information concerning relations between various temperament dimensions and with externalizing behaviors as reported by both youth and mothers. Bivariate correlations were used to compare associations between temperament and externalizing behaviors as reported by youth and mothers, respectively. Mother-son agreement for both temperament as well as externalizing behaviors was examined.

Associations Among Temperament, Externalizing Behavior, and Executive Functions

Associations between the three empirically-derived EF scales and both self- and mother-reported temperament and externalizing behaviors were examined. Multivariate linear regression models were run separately to examine the unique contributions of temperament and the three empirically derived EF scales to predict the three youth- and mother-reported externalizing behavior scales

Hierarchical Multiple Regression Analyses Predicting Externalizing Behaviors

Hierarchical multiple regression analyses predicting self- and mother-reported externalizing behavior were conducted to determine the incremental variance explained by EF above and beyond temperament for both self- and mother-reports. To avoid distorting the results due to multicollinearity among the various SNAP scales, only the three temperament scales were included, rather than all bivariate predictors. Three regressions for both self- and mother-report predicting Rule-Breaking Behavior, Aggression, and overall Externalizing Behavior were run. Each regression consisted of three steps: (1) age; (2) the three temperament traits; and (3) EF dimensions.

Relative Contribution of Temperament and Executive Functioning to Externalizing Behavior

Regression-based latent variable modeling techniques were used to estimate latent factor scores for Disinhibition, Negative Temperament, Positive Temperament, and the three EF dimensions, and externalizing behaviors. For the three higher order temperament dimensions as well as externalizing behaviors, self- and mother-report were used to estimate the latent factors. For EF, D-KEFS achievement scores previously shown to load on particular factors (Latzman & Markon, under review) were used to estimate each latent EF factor. Externalizing behavior was estimated by the manifest indicators of self- and mother-reported rule-breaking behavior and aggression. Three separate regression models were run: (1) the three latent temperament dimensions were regressed on externalizing behavior; (2) the three latent EF dimensions were regressed on externalizing behavior; and (3) both the three temperament and three EF dimensions were regressed simultaneously on externalizing behavior. Standardized loadings were examined to determine the unique contribution of temperament and EF to externalizing behavior.

RESULTS

Preliminary Analyses and Missing Data

The multiple imputation program in SAS Version 9.1 was used to impute missing items (i.e., scores were not imputed if an entire measure was missing). This approach uses maximum likelihood estimates for missing data and includes a random error component to prevent artificial inflation of inter-correlations. Descriptives (means, standard deviations, minimum and maximum values) for all scales are presented in Table 2.

SNAP-Y temperament and trait scale intercorrelations are presented in Table 3. Because a number of Disinhibition items are shared with related scales, the nonoverlapping version of this scale was used in all subsequent SNAP-Y analyses. Internal consistency reliabilities (Cronbach's coefficient alpha) are presented in the diagonal. Reliabilities ranged from .90 (Negative Temperament) to .54 (Propriety) with an average value of .67. The reliabilities in the current sample, while lower on many scales than those reported previously (Linde et al., unpublished manuscript), are largely consistent with previous research.

SNAP-ORF temperament and trait scale intercorrelations are presented in Table 4. Internal consistency reliabilities (Cronbach's coefficient alpha) are presented in the diagonal. Reliabilities ranged from .75 (Mistrust) to .27 (Dependency) with an average value of .65; average interitem correlations (AICs) ranged from .60 (Mistrust and Manipulativeness) to .16 (Dependency) with an average value of .47. It is important to note that each scale of the SNAP-ORF is comprised of either two or three items, except for Eccentric Perceptions that is comprised of only one. Thus, the AICs generally are considerably higher than for typically longer scales of the same alpha.

Relevant YSR and CBCL scale intercorrelations are presented in Table 5. Internal consistency reliabilities (Cronbach's coefficient alpha) are presented in the diagonal. Reliabilities ranged from .81 to .92 with an average value of .83 for the YSR and .89 for

the CBCL; AIC's ranged from .17 (YSR externalizing composite) to .36 (CBCL Aggression) with an average value of .19 for the YSR and .28 for the CBCL.

Intercorrelations among the three empirically derived EF scales are presented in Table 6. The three EF scales were moderately correlated with one another, as expected based on previous psychometric work on the D-KEFS (Latzman & Markon, under review). Internal consistency reliabilities (Cronbach's coefficient alpha) are presented in the diagonal. Reliabilities ranged from .70 for Inhibition to .81 for Conceptual Flexibility (average = .75).

Relations Between Key Demographic Variables and Dependent Variables

Table 7 presents correlations between all dependent variables, namely youth- and mother-report of externalizing behaviors, and key demographic factors. Only youth age was significantly correlated with the dependent variables. Specifically, youth age evidenced a significant moderate positive association with youth-reported rule-breaking behavior and externalizing composite. Maternal age and education and total family income were not significantly associated with youth- or mother-report on the externalizing scales. Therefore, youth age will be included in all multivariate analyses predicting externalizing behaviors.

Associations Between Temperament and Executive Functioning

Correlations between self- and mother-reported temperament and the three empirically derived EF scales are presented in Table 8. There was no statistically significant difference in the degree to which mothers' versus youth report of temperament correlated with youth EF. Both youth- and mother-reported NT and related traits showed some significant correlations with Conceptual Flexibility and Inhibition, although the only consistent correlations were between mother-reported NT and Inhibition. Both youth- and mother-reported PT and related traits showed some significant associations

with Monitoring, and Disinhibition and related traits were related to Inhibition for mothers' reports only. Interestingly, both youth- and mother-reported NT and related traits were as related to EF, especially Inhibition, as was Disinhibition and related traits.

Associations Among Same-Informant Temperament and Externalizing Behaviors

Correlations of self- and mother-reported youth temperament with externalizing behaviors are shown in Tables 9 and 10, respectively. Patterns of correlations between youths' and mothers' reports of youth temperament and externalizing behavior were highly similar. In general, both Disinhibition and NT and their associated traits evidenced moderate to large correlations with all three indices of the externalizing behavior for both self- and mother-reports.

Convergent and Discriminant Correlations Between Youth Self-Reported and Mother-Reported Temperament and Externalizing Behaviors

Correlations between youth self-reported SNAP-Y temperament and mother-reported SNAP-ORF temperament are shown in Table 11. Convergent correlations across all trait scales ranged from .15 for Workaholism to .42 for Disinhibition. Convergent correlations for the three temperament trait scales were higher than for the specific scales, with correlations ranging from .35 for NT to .42 for Disinhibition, with the exception of Detachment (r = .41). For the three temperament trait scales, as well as three other trait scales (Dependency, Entitlement, and Detachment), the convergent correlation was higher than any discriminant correlation. Some discriminant correlations, however, were as high, or higher, than the convergent ones. For example, SNAP-Y Mistrust was correlated with SNAP-ORF Negative Temperament at .31 while convergent the convergent correlation for Mistrust was .30. SNAP-ORF Manipulativeness was correlated with SNAP-Y Disinhibition at .32 while the convergent correlations for Manipulativeness was .28. Also evidencing a stronger discriminant versus convergent

correlation was SNAP-Y Exhibitionism, which was correlated with SNAP-ORF Detachment at -.39 while the convergent correlation was a non-significant .05. It is worth noting, however, that most of the high discriminant correlations were between scales in the same higher order domain (e.g., Mistrust and Manipulativeness are primary trait scales in the Negative Temperament and Disinhibition domains, respectively).

Correlations between youth self-report and mother-reported externalizing behaviors are shown in Table 5. Convergent correlations were .49 for rule-breaking behavior and .19 for aggressive behaviors, a statistically significant difference ($t = 3.59$, $p < .001$), with a correlation of .28 for the externalizing composite score. Thus, although youth and their mothers generally shared a view of sons' rule breaking, they had more discrepant views of sons' aggressive behavior.

Associations Between Executive Functioning and Self- and Mother-Reported Externalizing Behaviors

Correlations of EF with self- and mother-reported externalizing behaviors are shown in Table 12. Youth-reported externalizing behavior was not associated with any of the three empirically derived EF scales. However, all three of the mother-reported externalizing behavior indices were significantly negatively associated with Conceptual Flexibility (range = -.15 to -.19). Neither Monitoring nor Inhibition was associated with mother report of externalizing behaviors.

Predicting Youth-Reported Externalizing Behaviors from Youth-Reported Temperament and Executive Functioning

Hierarchical multiple-regression analyses were performed to determine whether EF contributed incremental variance beyond temperament in predicting youth-reported externalizing behaviors, in separate three-step procedures for Rule-Breaking Behaviors, Aggression, and the Externalizing Composite, controlling for age in Step 1 (see Tables 13-15, respectively). Age predicted a significant 8% of the variance in Rule-Breaking

Behavior (Table 13), higher Negative Temperament and Disinhibition scores predicted an additional 31% of the variance, and EF predicted an additional trend-level 2%. For Aggression, age predicted a non-significant 1% of the variance (Table 14), higher Negative Temperament and Disinhibition scores predicted an additional 37% of the variance, and EF predicted an additional non-significant 1%. Age predicted a significant 5% of the variance of the externalizing composite score (Table 15), higher Negative Temperament and Disinhibition scores predicted an additional 44% of the variance, and EF predicted no additional variance. Temperament and EF did not significantly interact to predict youth-any of the youth-reported externalizing scales.

Predicting Mother-Reported Externalizing Behaviors from Mother-Reported Temperament and Executive Functioning

Hierarchical multiple-regression analyses were performed to determine whether EF contributed incremental variance beyond temperament in predicting mother-reported externalizing behaviors, in separate three-step procedures for Rule-Breaking Behaviors, Aggression, and the Externalizing Composite, controlling for age in Step 1 (see Tables 16-18, respectively).

Age predicted a non-significant 0% of the variance in mother-reported Rule-Breaking Behavior (Table 16), higher Negative Temperament and Disinhibition scores predicted an additional 28% of the variance, and lower Conceptual Flexibility predicted an additional 3%. For Aggression, age predicted a significant 2% of the variance (Table 17), higher Negative Temperament and Disinhibition scores predicted an additional 44% of the variance, and EF predicted an additional non-significant 1%. Age predicted a 0% of the variance of the externalizing composite score (Table 18), higher Negative Temperament and Disinhibition scores predicted an additional 44% of the variance, and lower Conceptual Flexibility predicted an additional, significant 2%. One significant interaction between temperament and EF emerged: Conceptual Flexibility moderated the

association between Rule-Breaking Behavior and NT. Specifically, low Conceptual Flexibility was significantly associated with Rule-Breaking Behavior for youth high (versus low) on NT. Due to the possibility of Type I Error, this finding should be interpreted cautiously.

Structural Equation Modeling Procedures Predicting Latent Externalizing Behavior from Big Three Temperament and Executive Functioning

Finally, structural equation modeling techniques were used to examine the joint contributions of temperament and EF in explaining externalizing behavior at the latent variable level. Latent temperament and externalizing behavior variables were estimated via manifest youth self- and mother-reported temperament and externalizing behavior. The three EF dimensions were estimated via D-KEFS achievement scores consistent with previous factor analytic work (Latzman & Markon, under review). Table 19 shows loadings of all manifest indicators on each of the latent variables. Figure 1 shows the structural equation model when latent externalizing behavior, as estimated via youth- and mother-report, is regressed on latent EF and temperament. When all domains are considered jointly, temperamental Disinhibition (β = .99, t = 7.63, p < .001) showed a significant main effect, as did Conceptual Flexibility (β = -.20, t = -2.01, p < .05) and Inhibition (β = .35, t = 2.62, p < .01). Whereas a significant negative zero-order association between Conceptual Flexibility and externalizing behavior was found, the association with Inhibition was positive when temperament was included in the model. Without temperament in the model, however, the relation between Inhibition and externalizing behavior was zero, suggesting a suppressor effect of Disinhibition. That is, the effect of Inhibition is evident only in the presence of temperamental Disinhibition, indicating that there is variance in neuropsychological Inhibition that is non-overlapping with temperamental Disinhibition that accounts for a significant part of the variance in externalizing behavior.

Table 1.

Sample Demographics

	N or *M*	% or *SD*
Youth age (yrs.)	13.6	1.4
Mother age (yrs.)	44.2	5.3
Mother Education		
Less than High School	1	0.6
High School Degree	8	4.6
Some College	40	23.0
College Degree	73	42.0
Post-Graduate Degree	52	29.9
Youth Race		
White	153	87.9
Non-White	21	12.1
Total Combined Family Income		
< $25,000	3	1.7
$26,000-$35,000	9	5.2
$36,000-$50,000	11	6.4
$51,000-$65,000	31	17.9
$66,000-$80,000	21	12.1
$81,000-$100,000	39	22.5
>$100,000	59	34.1

Note. $N = 174$.

Table 2.

Descriptive Statistics for All Study Variables

	Mean	Standard Deviation	Min.	Max.
SNAP-Y				
Negative Temperament	9.08	6.31	0	26
Mistrust	4.15	3.12	0	16
Manipulativeness	7.52	3.10	0	18
Aggression	6.44	3.45	1	17
Self-Harm	5.18	1.77	2	12
Eccentric Perceptions	4.90	2.38	1	12
Dependency	5.36	2.72	0	14
Positive Temperament	18.97	5.61	0	27
Exhibitionism	6.66	3.10	0	14
Entitlement	7.71	2.80	1	14
Detachment	6.42	2.50	2	14
Disinhibition	6.19	2.99	0	12
Impulsivity	7.61	3.40	1	17
Propriety	9.42	3.03	2	16
Workaholism	5.21	2.57	0	12
SNAP-ORF				
Negative Temperament	7.61	3.25	3	16
Mistrust	4.28	2.20	2	11
Manipulativeness	7.89	3.62	3	17

Table 2 (Continued)

	Mean	Standard Deviation	Min.	Max.
Aggression	4.97	2.22	2	12
Self-Harm	3.18	1.84	2	12
Eccentric Perceptions	1.63	1.19	1	6
Dependency	6.11	2.21	2	12
Positive Temperament	8.48	2.07	2	12
Exhibitionism	7.24	1.18	3	11
Entitlement	5.89	2.38	2	11
Detachment	8.05	3.57	3	18
Disinhibition	8.83	3.48	3	18
Impulsivity	6.06	2.55	2	12
Propriety	7.85	2.36	2	12
Workaholism	5.12	2.25	2	12
D-KEFS				
Sorting Test: Free Sort	10.41	2.64	3	16
Sorting Test: Free Sort Description	9.98	2.55	3	15
Sorting Test: Sort Recognition	8.74	3.18	1	16
Trail Making Test	11.03	2.55	1	15
Color-Word Test: Inhibition	10.68	2.57	2	16
Color-Word Test: Inhibition/Switching	10.05	2.36	3	15
Twenty Questions Test	11.60	2.17	3	16

Table 2 (Continued)

	Mean	Standard Deviation	Min.	Max.
Verbal Fluency Test: Letter Fluency	10.44	3.24	2	18
Verbal Fluency Test: Category Fluency	11.37	3.26	3	19
Verbal Fluency Test: Category Switching	10.43	3.15	1	19
Verbal Fluency Test:				
Category Switching Accuracy	11.12	2.77	1	19
Design Fluency Test	12.06	2.84	5	19
Tower Test: Total Achievement	10.93	2.31	5	18
Tower Test: Accuracy	9.27	2.57	1	14
Word Context Test	10.58	2.66	2	17
CBCL				
Rule-Breaking Behavior	1.85	2.61	0	17
Aggression	4.01	4.89	0	26
Externalizing Composite	5.86	6.87	0	42
YSR				
Rule-Breaking Behavior	3.63	3.22	0	21
Aggression	7.51	4.17	0	22
Externalizing Composite	11.14	6.50	0	35

Table 3.

SNAP-Y Temperament and Trait Scale Intercorrelations

SNAP-Y	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. **Negative Temperament**	*.90*														
2. Mistrust	**.60**	*.75*													
3. Manipulativeness	**.38**	**.45**	*.62*												
4. Aggression	**.40**	**.48**	**.56**	*.75*											
5. Self-Harm	**.26**	**.30**	**.34**	**.33**	*.58*										
6. Eccentric Perceptions	**.50**	**.66**	**.45**	**.48**	**.33**	*.59*									
7. Dependency	**.33**	.17	.14	.08	-.11	.14	*.58*								
8. **Positive Temperament**	-.18	-.07	-.06	-.12	-.11	.02	-.07	*.87*							
9. Exhibitionism	.03	.06	**.28**	.15	.07	.19	.09	**.45**	*.68*						
10. Entitlement	.10	.21	.24	.12	.19	**.33**	-.13	**.33**	**.29**	*.62*					
11. Detachment	**.29**	**.35**	.12	**.29**	**.27**	**.30**	-.15	**-.46**	**-.37**	-.05	*.56*				
12. **Disinhibition**	**.35**	**.42**	**.75**	**.59**	**.39**	**.41**	.11	-.22	.21	.09	.18	*.73*			

Table 3 (Continued)

SNAP-Y	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13. Impulsivity	.18	**.29**	**.48**	**.47**	**.29**	.23	.08	-.21	.16	.08	.08	**.72**	*.68*		
14. Propriety	.07	.08	-.15	-.19	-.14	.12	.07	**.38**	.07	**.30**	-.13	**-.40**	**-.46**	*.54*	
15. Workaholism	**.28**	**.32**	.09	.11	.17	**.38**	.02	**.35**	**.26**	**.46**	.19	-.03	-.16	**.32**	*.58*

Notes. N =171; Correlations ≥ .25 are shown in **boldface**. Correlations of ≥|.15| are significant, $p < .05$; ≥ |.20|, $p < .01$; ≥ |.25|, $p < .001$.

SNAP-Y = Schedule for Nonadaptive and Adaptive Personality-Youth Version.

Internal consistency reliabilities (Cronbach's coefficient alphas) shown in *italics* in the diagonal.

Table 4.

SNAP-ORF Scale Intercorrelations

SNAP-ORF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. **Negative Temperament**	*.73*														
2. Mistrust	**.44**	*.75*													
3. Manipulativeness	**.38**	**.43**	*.82*												
4. Aggression	**.66**	**.37**	**.56**	*.73*											
5. Self-Harm	**.45**	**.41**	**.45**	**.51**	*.65*										
6. Eccentric Perceptions[a]	**.33**	.24	.21	**.26**	**.35**	--									
7. Dependency	**.28**	.21	.02	.13	.23	.24	*.27*								
8. **Positive Temperament**	-.09	**-.28**	-.24	-.11	**-.25**	-.11	-.19	*.67*							
9. Exhibitionism	.15	.02	.01	.00	.11	.01	-.17	.20	*.70*						
10. Entitlement	.15	.22	**.32**	.24	-.12	.13	.04	.01	.07	*.45*					
11. Detachment	.14	**.45**	.19	.18	.21	.08	.05	**-.49**	-.14	-.05	*.74*				
12. **Disinhibition**	**.33**	**.33**	**.77**	**.50**	**.43**	.16	.00	**-.28**	.01	.24	.10	*.75*			

Table 4 (Continued)

SNAP-ORF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13. Impulsivity	**.29**	**.28**	.60	**.47**	**.42**	.16	.04	-.08	.07	.24	.02	**.70**	*.65*		
14. Propriety	-.09	-.18	**-.58**	**-.37**	**-.27**	-.05	.03	**.26**	.07	-.22	-.02	**-.61**	**-.47**	*.67*	
15. Workaholism	-.17	-.15	**-.58**	**-.30**	-.20	-.07	-.03	**.28**	-.03	-.10	-.03	**-.67**	**-.48**	**.52**	*.58*

Notes. N =174; Correlations ≥ .25 are shown in **boldface**. Correlations of ≥|.15| are significant, $p < .05$; ≥ |.20|, $p < .01$; ≥ |.25|, $p < .001$.

SNAP-ORF =Schedule for Nonadaptive and Adaptive Personality-Other Report Form.

Internal consistency reliabilities (Cronbach's coefficient alphas) shown in *italics* in the diagonal.

[a]A single item; alpha cannot be calculated.

Table 5.

Interrelations among Externalizing Scales

	Youth Self Report			Child Behavior Checklist		
	RBB	Agg	Ext	RBB	Agg	Ext
Youth Self Report						
Rule-Breaking Behavior	*.81*					
Aggression	**.53**	*.81*				
Externalizing Composite	**.84**	**.91**	*.87*			
Child Behavior Checklist						
Rule-Breaking Behavior	**.49**	.16	**.35**	*.84*		
Aggression	.18	.19	.21	**.64**	*.91*	
Externalizing Composite	**.31**	.20	**.28**	**.84**	**.96**	*.92*

Notes. N =174; Correlations $\geq$ .25 are shown in **boldface**. Correlations of $\geq$ |.15| are significant, $p < .05$; $\geq$ |.20|, $p < .01$; $\geq$ |.25|, $p < .001$.

RBB = Rule-Breaking Behavior.

Agg = Aggression.

Ext = Externalizing Composite.

Internal consistency reliabilities (Cronbach's coefficient alphas) shown in *italics* in the diagonal.

Table 6.

Intercorrelations among Executive Functioning Scales

Executive Functioning Scale	Conceptual Flexibility	Monitoring	Inhibition
Conceptual Flexibility	*.81*		
Monitoring	**.39**	*.74*	
Inhibition	**.40**	**.39**	*.70*

Notes. N =174. Correlations $\geq$ .25 are shown in **boldface**. Correlations of $\geq$ |.15| are significant, $p < .05$; $\geq$ |.20|, $p < .01$; $\geq$ |.25|, $p < .001$.

Internal consistency reliabilities (Cronbach's coefficient alpha) shown in *italics* in the diagonal.

Table 7.

Relations between Key Demographic Variables and Externalizing Behavior

	Youth Self Report			Child Behavior Checklist		
	RBB	Agg	Ext	RBB	Agg	Ext
Youth Age	**.31**	.14	**.25**	.03	-.15	-.10
Maternal Age	.03	.04	.04	-.09	-.04	-.08
Maternal Education	-.07	-.08	-.09	.03	-.01	.01
Family Income	-.10	-.06	-.09	-.03	-.10	-.08

Notes. N =174; Correlations $\geq$ .25 are shown in **boldface**. Correlations of $\geq |.15|$ are significant, $p < .05$; $\geq |.20|$, $p < .01$; $\geq |.25|$, $p < .001$.

Agg = Aggression.

RBB = Rule-Breaking Behavior.

Ext = Externalizing Behavior Composite.

Table 8.

Relations between SNAP and D-KEFS Higher Order Scales

	Conceptual Flexibility		Monitoring		Inhibition	
SNAP	Youth	Mother	Youth	Mother	Youth	Mother
Negative Temperament	-.03	-.15	-.05	-.14	-.09	-.20*
Mistrust	-.14	-.22†	-.08	-.13	-.16	-.23*
Manipulativeness	-.09	-.12	.05	-.11	-.02	-.21*
Aggression	-.05	-.13	-.11	-.22*†	-.03	-.18
Self-Harm	-.16*	-.14	-.06	-.14	-.13	-.14
Eccentric Perceptions	-.17	-.13	-.01	-.08	-.16	-.20*
Dependency	-.22*†	-.11	-.06	-.02	-.14	-.11
Positive Temperament	-.01	.02	.16*	.13	.09	.08
Exhibitionism	-.01	.02	.23*†	.04	.03	.12
Entitlement	.02	.15	.16*	.12	.05	.01
Detachment	-.06	-.01	-.13	-.17	-.18*†	-.09
Disinhibition	-.01	-.03	-.07	-.10	-.06	-.24*†
Impulsivity	-.04	-.10	-.04	-.04	-.05	-.21*
Propriety	-.11*	.02	-.11*	-.02	-.07	.09
Workaholism	-.12	.10	-.12	.05	-.11	.20*

Notes. N =171 for youth and N =174 for mothers.

*Highest correlation in each row.

†Highest correlation in each column.

Table 8 (Continued)

Correlations of $\geq |.15|$ are significant, $p < .05$; $\geq |.20|$, $p < .01$; $\geq |.25|$, $p < .001$.

SNAP = Schedule for Nonadaptive and Adaptive Personality (for mothers, SNAP-2; for sons, SNAP-Y, Youth Version).

Table 9.

Relations between SNAP-Y and Externalizing Behavior

	Youth Self Report			Child Behavior Checklist		
SNAP-Y	RBB	Agg	Ext	RBB	Agg	Ext
Negative Temperament	**.26**	**.46**	**.47***	.13	.12	.14
Mistrust	**.46**	**.43**	**.50***	**.29†**	**.28†**	**.31†**
Manipulativeness	**.56**	**.55**	**.63***	**.26**	.18	.23
Aggression	**.41**	**.64*†**	**.61**	.20	.23	.24
Self-Harm	**.50***	**.34**	**.47**	.23	.17	.21
Eccentric Perceptions	**.42**	**.40**	**.47***	**.25**	**.28†**	**.29**
Dependency	.08	.08	.09*	-.03	.06	.03
Positive Temperament	-.17*	-.05	-.12	-.11	-.05	-.08
Exhibitionism	.16	.23*	.22	.03	-.00	.01
Entitlement	.11	.11	.13*	-.06	-.08	-.08
Detachment	.24*	.17	.23	.24	.19	.23
Disinhibition	**.59†**	**.55**	**.65*†**	**.27**	.16	.21
Impulsivity	**.45**	**.49**	**.54***	**.29†**	.19	.24
Propriety	-.17	-.17	-.19*	-.10	-.14	-.14
Workaholism	.13*	.11	.13*	.02	.01	.01

Notes. N =171. Correlations ≥ .25 are shown in **boldface**.

*Highest correlation in each row.

†Highest correlation in each column.

Correlations of ≥ |.15| are significant, $p < .05$; ≥ |.20|, $p < .01$; ≥ |.25|, $p < .001$.

SNAP-Y =Schedule for Nonapative and Adaptive Personality- Youth Version.

Table 9 (Continued)

Agg=Aggression.

RBB=Rule-Breaking Behavior.

Ext=Externalizing Behavior Composite.

Table 10.

Relations between SNAP-ORF and Externalizing Behaviors

	Youth Self Report			Child Behavior Checklist		
SNAP-ORF	RBB	Agg	Ext	RBB	Agg	Ext
Negative Temperament	.11	.21	.19	**.30**	**.59***	**.53**
Mistrust	**.28**	.10	.21	**.38**	**.39**	**.42***
Manipulativeness	**.27**	.17	.24	**.62*†**	**.55**	**.62*†**
Aggression	.23	**.28†**	**.29†**	**.45**	**.61*†**	**.61***
Self-Harm	**.32†**	.19	**.28**	**.49**	**.48**	**.53***
Eccentric Perceptions	.06	-.04	.00	.14	.18*	.18*
Dependency	-.06	-.08	-.08	.04	.10*	.09
Positive Temperament	-.20*	-.02	-.11	-.17	-.14	-.16
Exhibitionism	-.15*	-.01	-.07	-.08	.10	.04
Entitlement	.08	.11	.11	.15	**.28***	**.26**
Detachment	.13	-.06	.02	.17	.17	.19*
Disinhibition	**.28**	.23	**.28**	**.52**	**.52**	**.57***
Impulsivity	**.25**	.17	.24	**.49**	**.48**	**.53***
Propriety	-.24	-.18	-.23	**-.43***	**-.37**	**-.42**
Workaholism	-.19	-.15	-.19	**-.31**	**-.31**	**-.34***

Notes. N =174; Correlations ≥ .25 are shown in **boldface**.

*Highest correlation in each row.

†Highest correlation in each column.

Correlations of ≥|.15| are significant, $p < .05$; ≥ |.20|, $p < .01$; ≥ |.25|, $p < .001$.

SNAP-ORF =Schedule for Nonapative and Adaptive Personality- Other Report Form.

Table 10 (Continued)

Agg=Aggression.

RBB=Rule-Breaking Behavior.

Ext=Externalizing Behavior Composite.

Table 11.

Correlations between SNAP-Y and SNAP-ORF scales

	SNAP-ORF														
SNAP-Y	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Negative Temperament	**.35*†**	.31	.13	.26	.29*	.06	.11	-.12	.01	-.01	.08	.14	.14	-.07	-.09
2. Mistrust	.29	**.30**	.26	.43*†	.26	.05	-.04	-.14	-.07	.10	.09	.32	.23	-.22	-.20
3. Manipulativeness	.18	.11	**.28†**	.27	.27	.06	.04	-.23	-.20*	.16	-.06	.30	.21	-.27	-.22
4. Aggression	.28	.13	.25	**.31†**	.19	-.06	-.02	-.18	-.09	.12	.06	.33	.22	-.29	-.26
5. Self-Harm	.09	.15	.22	.13	**.26†**	.02	-.12	-.09	-.12	.19	.05	.21	.19	-.21	-.11
6. Eccentric Perceptions	.25†	.22	.24	.31	.24	**.18***	-.04	-.04	-.17	.09	.19	.24	.13	-.14	-.16
7. Dependency	.13	.07	-.01	.14	.09	-.02	**.18*†**	-.02	-.08	-.04	-.15	.04	.12	-.02	-.14
8. Positive Temperament	-.14	-.29	-.16	-.16	-.21	-.07	-.06	**.36*†**	.07	.07	-.36	-.17	-.12	.10	.22
9. Exhibitionism	.10	-.13	.02	-.08	-.08	-.03	-.08	.16	**.05**	.18	-.39†	-.01	.04	-.05	.03
10. Entitlement	-.01	-.04	-.02	-.12	-.13	-.10	-.07	.08	-.04	**.19*†**	-.00	-.09	-.07	-.01	.13

Table 11 (Continued)

SNAP-Y	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
11. Detachment	.25	.37*	.16	.28	.27	.12	.02	-.33	.00	-.03	**.41*†**	.24	.13	-.12	-.16
12. Disinhibition	.14	.10	.32*	.27	.21	-.02	-.09	-.24	-.10	.11	-.03	**.42*†**	.30	-.36*	-.35*
13. Impulsivity	.06	.06	.26	.27	.24	-.07	-.09	-.08	-.08	.06	-.07	.37†	**.34***	-.34	-.31
14. Propriety	-.11	-.07	-.15	-.19	-.23	-.05	.12	.11	-.13	-.07	-.01	-.24†	-.15	**.16**	.18
15. Workaholism	.05	.05	-.05	.06	-.03	.08	-.03	.04	.07	.03	.05	-.10	-.07	.06	**.15†**

Notes. N =171; Convergent correlations are shown in **boldface**. Correlations of $\geq$ l.15l are significant, $p < .05$; $\geq$ l.20l, $p < .01$; $\geq$ l.20l, $p < .01$; $\geq$ l.25l, $p < .001$.

*Highest correlation in column.

†Highest correlation in row.

SNAP-Y =Schedule for Nonadaptive and Adaptive Personality- Youth Version.

SNAP-ORF=Schedule for Nonadaptive and Adaptive Personality- Other Report Form.

Table 12.

Relations between Executive Functioning and Externalizing Behaviors

	Conceptual Flexibility	Monitoring	Inhibition
Youth Self Report			
Rule-Breaking Behavior	-.10*	.04	-.02
Aggression	.11*	.05†	.08
Externalizing Composite	.02	.05*†	.04
Child Behavior Checklist			
Rule-Breaking Behavior	-.19*†	-.04	-.10
Aggression	-.15*	-.02	-.12
Externalizing Composite	-.18*	-.03	-.13†

Notes. N =174.

*Highest correlation in each row.

†Highest correlation in each row.

Correlations of $\geq$|.15| are significant, $p < .05$; $\geq$ |.20|, $p < .01$; $\geq$ |.25|, $p < .001$.

Table 13.

Predicting Youth Self-Reported Rule-Breaking Behavior from Self-Reported Youth Temperament and Executive Functioning

	Step 1 (R^2=.08)		Step 2 (R^2=.39)		Step 3 (R^2=.41)	
Predictors	β	t	β	t	β	t
Step 1: Age	.71	4.01**	.44	2.98*	.46	2.41*
Step 2: Personality						
Negative Temperament			.07	2.19†	.07	2.17†
Positive Temperament			-.00	-.12	-.02	-.45
Disinhibition			.33	7.85**	.32	7.88**
Step 3: Executive Functioning						
Conceptual Flexibility					-.24	-2.45†
Monitoring					.16	1.59
Inhibition					.01	.08

Notes. N =171.

F-test of change from Step 2 to Step 3: F = 2.41; df = 3,163; $p < .10$.

**$p < .001$.

*$p < .01$.

$^{\dagger}p < .05$.

Table 14.

Predicting Youth Self-Reported Aggression from Self-Reported Temperament and Executive Functioning

	Step 1 (R^2=.01)		Step 2 (R^2=.38)		Step 3 (R^2=.39)	
Predictors	β	t	β	t	β	t
Step 1: Age	.37	1.57	-.01	-.07	-0.09	-.46
Step 2: Personality						
Negative Temperament			.21	4.90**	.22	5.09**
Positive Temperament			.08	1.72	.08	1.65‡
Disinhibition			.38	7.09**	.38	7.17**
Step 3: Executive Functioning						
Conceptual Flexibility					.17	1.30
Monitoring					-.02	-.12
Inhibition					.21	1.17

Notes. N =171.

F-test of change from Step 2 to Step 3: F = 1.74; df = 3,163; $p > .10$.

**$p < .001$.

*$p < .01$.

†$p < .05$.

‡$p < .10$.

Table 15.

Predicting Youth Self-Reported Externalizing Composite from Self-Reported Youth Temperament and Executive Functioning

	Step 1 (R^2=.05)		Step 2 (R^2=.49)		Step 3 (R^2=.49)	
Predictors	*β*	*t*	*β*	*t*	*β*	*t*
Step 1: Age	1.09	2.99*	.43	1.57	.37	1.34
Step 2: Personality						
Negative Temperament			.28	4.67**	.29	4.74**
Positive Temperament			.08	1.16	.06	.92
Disinhibition			.71	9.31**	.71	9.26**
Step 3: Executive Functioning						
Conceptual Flexibility					-.07	-.40
Monitoring					.15	.77
Inhibition					.22	.86

Notes. N =171.

F-test of change from Step 2 to Step 3: F = .63; df = 3,163; p > .10.

**p < .001.

*p < .01.

Table 16.

Predicting Mother-Reported Rule-Breaking Behavior from Mother-Reported Youth Temperament and Executive Functioning

	Step 1 (R^2=.00)		Step 2 (R^2=.28)		Step 3 (R^2=.31)	
Predictors	β	t	β	t	β	t
Step 1: Age	.07	.44	.13	1.05	.14	1.13
Step 2: Personality						
Negative Temperament			.12	2.19†	.11	1.97†
Positive Temperament			-.02	-.29	-.03	-.35
Disinhibition			.35	6.64**	.38	7.02**
Step 3: Executive Functioning						
Conceptual Flexibility					-.27	-3.14*
Monitoring					.05	.51
Inhibition					.19	1.57

Notes. N =174.

F-test of change from Step 2 to Step 3: F = 3.43; df = 3,166; $p < .05$.

**$p < .001$.

*$p < .01$.

$^{\dagger}p < .05$.

Table 17.

Predicting Mother-Reported Aggression from Mother-Reported Youth Temperament and Executive Functioning

	Step 1 (R^2=.02)		Step 2 (R^2=.46)		Step 3 (R^2=.47)	
Predictors	β	t	β	t	β	t
Step 1: Age	-.55	-2.03†	-.33	-1.63	-.36	-1.74‡
Step 2: Personality						
Negative Temperament			.69	7.63**	.69	7.63**
Positive Temperament			-.01	-.05	-.03	-.23
Disinhibition			.51	5.84**	.54	6.08**
Step 3: Executive Functioning						
Conceptual Flexibility					-.28	-2.02†
Monitoring					.18	1.23
Inhibition					.30	1.50

Notes. N =174.

F-test of change from Step 2 to Step 3: F = 2.15; df = 3,166; $p < .10$.

**$p < .001$.

†$p < .05$.

‡$p < .10$.

Table 18.

Predicting Mother-Reported Externalizing Composite from Mother-Reported Youth Temperament and Executive Functioning

	Step 1 (R^2=.00)		Step 2 (R^2=.44)		Step 3 (R^2=.46)	
Predictors	β	t	β	t	β	t
Step 1: Age	-.49	-1.27	-.20	-.69	-.22	-.74
Step 2: Personality						
Negative Temperament			.81	6.31**	.80	6.27**
Positive Temperament			-.03	-.16	-.06	-.31
Disinhibition			.86	6.97**	.91	7.33**
Step 3: Executive Functioning						
Conceptual Flexibility					-.55	-2.78*
Monitoring					.22	1.09
Inhibition					.50	1.74‡

N =174.

F-test of change from Step 2 to Step 3: F = 3.15; df = 1,158; $p < .05$.

**$p < .001$.

*$p < .01$.

‡$p < .10$.

Table 19.

Manifest Indicators of Latent Variables Included In Full Structure Equation Model

Variable	Loading
Externalizing	
YSR Rule-Breaking Behavior	.65
YSR Aggression	.50
CBCL Rule-Breaking Behavior	.75
CBCL Aggression	.50
Negative Temperament	
SNAP-Y Negative Temperament	.41
SNAP-ORF Negative Temperament	.77
Positive Temperament	
SNAP-Y Positive Temperament	.34
SNAP-ORF Positive Temperament	.91
Disinhibition	
SNAP-Y Disinhibition	.65
SNAP-ORF Disinhibition	.62
Conceptual Flexibility	
D-KEFS Sorting Condition 2	.95
D-KEFS Sorting Condition 1	.89
D-KEFS Sorting Condition 3	.63
D-KEFS Word Context Test	.43
Monitoring	
D-KEFS Verbal Fluency Condition 2	.63

Table 19 (continued)

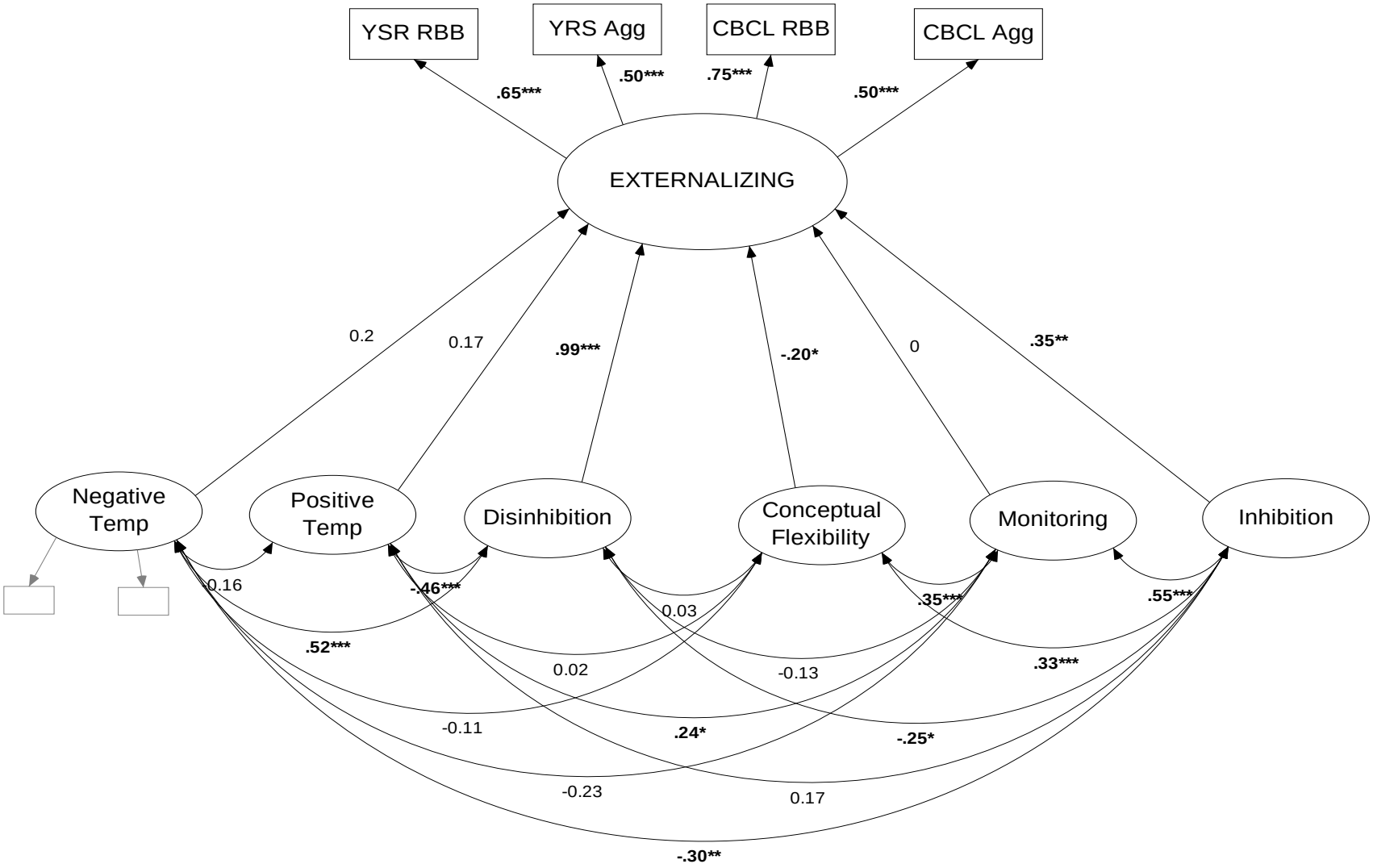
Variable	Loading
D-KEFS Verbal Fluency Condition 1	.61
D-KEFS Verbal Fluency Condition 4	.60
D-KEFS Twenty Questions	.24
Inhibition	
D-KEFS Color-Word Condition 3	.81
D-KEFS Color-Word Condition 4	.76
D-KEFS Design Fluency	.47
D-KEFS Trail Making Test	.43
D-KEFS Tower Test-Achievement	.32
D-KEFS Tower Test-Accuracy	.27

Notes. N =174.

SNAP=Schedule for Nonadaptive and Adaptive Personality (for mothers, SNAP-2, 2nd Edition; for sons, SNAP-Y, Youth Version).

D-KEFS=Delis-Kaplan Executive Function System.

Figure 1. Structural Equation Modeling Procedures Predicting Latent Externalizing Behavior from Big Three Temperament and Executive Functioning. Standardized model coefficients shown. All latent variances constrained to one. Not all indicators are shown. * $p < .05$; ** $p < .01$; *** $p < .001$. CBCL=Child Behavior Checklist. YSR=Youth Self-Report. RBB=Rule-Breaking Behavior. Agg=Aggressive Behavior. Negative Temp=Negative Temperament. Positive Temp=Positive Temperament.


YSR RBB
YRS Agg
CBCL RBB
CBCL Agg
.65***
.50***
.75***
.50***
EXTERNALIZING
0.2
0.17
.99***
-.20*
0
.35**
Negative Temp
Positive Temp
Disinhibition
Conceptual Flexibility
Monitoring
Inhibition
0.16
-.46***
0.03
.35***
.55***
.52***
0.02
-0.13
.33***
-0.11
.24*
-.25*
-0.23
0.17
-.30**

DISCUSSION

Substantial empirical and theoretical literatures link both EF and temperament to youth externalizing behaviors (Caspi et al., 1995; Krueger et al., 2007; Morgan & Lilienfeld, 2000). All three major etiological theories of externalizing behaviors (Moffitt, 1993; Frick, et al., 2003; Patterson, et al., 2000) implicate both temperamental and neuropsychological as underlying etiological risk factors. Rarely, however, have these domains been considered in concert. The current investigation is the first to examine triangular relations among youth temperament, EF, and externalizing in a sample of male youth and their mothers.

Results revealed significant convergence between youth self-report and mother-report of temperament and behavior. Specifically, convergence for primary traits were small to moderate whereas those for the three temperaments trait scales were consistently strong. The convergent correlation for youth self- and mother-reported externalizing behavior was significantly stronger for rule-breaking behavior than for aggression. This discrepency may be the result of the limited opportunities mothers have to observe certain aspects of their sons' behavior in multiple contexts. That is, rule-breaking behavior spans multiple contexts and thus more often comes to the attention of the parent (e.g., occurs at home, or parents are notified via teachers) than does aggressive behavior, which may occur largely in the context of peer relations.

The current investigation is among the first to examine relations between trait models of temperament and EF as assessed by performance on traditional neuropsychological measures in youth. Novel relations between temperament and EF were found, contributing to our understanding of relations between these two theoretically related domains. Overall, mothers' report of temperament correlated slightly more strongly and consistently with youth EF than did youths' report. In general, NT and Disinhibition and related traits were correlated with the EF dimension of Conceptual Flexibility, which relates to the ability to engage in flexible thinking and behavior, and

Inhibition, which concerns the ability to inhibit a dominant or automatic response deliberately. Positive Temperament and related traits were associated with Monitoring, a dimension of EF that relates to the ability to actively monitor and evaluate information in working memory.

These findings are interesting for many reasons. First, contrary to theoretical assertions (e.g., Nigg, 2000), NT traits were as, if not more strongly related to EF as were Disinhibition traits. While it long has been accepted that temperamental Disinhibition is likely subserved by the frontal lobes (Damasio et al., 1994), functional imaging work (Canli, Zhao, Desmond, Kang, Gross, & Gabrieli, 2001) and cortical thickness data (Wright et al., 2006) are consistent with the current findings, suggesting that the prefrontal cortex also may be associated with NT. These findings suggest that NT traits should be included when examining relations among these domains, which is not typically done (e.g., Giancola et al., 1998; 2006; Martel et al., 2007). These results may also suggest that EF, or at least aspects of EF, may comprise neuropsychological indicators of higher order traits (e.g., Alpha; Digman, 1997; Markon et al., 2005), thus suggesting an avenue for future work.

Second, the positive association between PT and Monitoring suggests that PT may have an active working-memory component. This relation makes theoretical sense, as the abilities tapped by Monitoring are active rather than passive in nature; that is, they require conscious manipulation of the content of working memory (Latzman & Markon, under review). The abilities tapped by this dimension may be reflected behaviorally in individuals high on PT, as such individuals tend to exhibit greater active approach tendencies and to be more outgoing and energetic (Clark & Watson, 2008).

Results are consistent with previous research indicating relations between externalizing behaviors and both temperament (Caspi et al., 1995; Krueger et al., 2007) and EF (Morgan & Lilienfeld, 2000). Patterns of correlations for youth temperament and externalizing behavior were highly similar for both youth and mother report of these

constructs. In general, both Disinhibition and NT and their associated traits evidenced moderate to large correlations with Rule-Breaking Behavior, Aggression, and the externalizing composite scale for both youth self- and mother-reports. Disinhibition and its related traits, in general, evidenced stronger relations with all externalizing scales than did NT.

When Big Three temperament traits were considered jointly at the multivariate level, both Disinhibition and NT evidenced significant main effects in predicting the externalizing composite score for both youth self- and mother-report, with stronger loadings evidenced from Disinhibition, although the difference was not as striking for mother report. When the two externalizing scales were examined individually, however, interesting results emerged. In the prediction of both youth- and mother-reported rule-breaking behavior, Disinhibition evidenced a greater contribution than did NT. For aggression, however, Disinihibition evidenced a slightly greater contribution than NT for youth self-report, but the reverse was true for mother-report; that is, NT's contribution was greater than Disinhibition's for mother's report. These results, consistent with previous findings among college-aged individuals (Burt & Donnellan, 2008), suggest differential contributions of Disinhibition and NT to various forms of externalizing behaviors. These findings, in conjunction with previous factor-analytic work (e.g., Tackett, Krueger, Sawyer, & Graetz, 2003), suggest that two correlated subfactors (i.e., aggression and rule-breaking behavior) may provide a more accurate representation of antisocial behavior in youth than a single unitary factor.

When relations between externalizing behaviors and the three dimensions of EF were examined, different findings for self- and mother-reported externalizing behaviors emerged. Significant relations between EF and externalizing behaviors emerged for mother, but not youth self-report. *Only* Conceptual Flexibility, a dimension tapping one's general ability to engage in flexible thinking and behavior (Latzman & Markon, under review; Miyake et al., 2000), was associated with externalizing behaviors. These results

remained at the multivariate level for the externalizing composite score and rule-breaking behavior, but not for aggression. As discussed previously, this finding may be consistent with prior research indicating distinct temperamental contributions to these two forms of externalizing behaviors (Burt & Donnellan, 2008). This unique contribution of temperamental disinhibition may be related to the association between rule-breaking behavior and regulatory abilities, both affective and cognitive, and be indicated here with EF. It is important to note that although statistically significantly associated, the magnitude of relations between EF and externalizing behaviors was small, suggesting that EF likely operates in conjunction with multiple other determinants in explaining externalizing behaviors, as was evident from the hierarchical multiple regression analyses.

Results of hierarchical multiple regression analyses indicated that no EF dimensions contributed to the prediction of any of the youth-reported externalizing scales above and beyond temperament. However, for the mother-reported externalizing composite and Rule-Breaking scale, Conceptual Flexibility significantly contributed to a model above and beyond that of temperament. No other EF dimensions contributed to mother-reported externalizing behavior. This finding is in contrast to previous research (Martel et al., 2007) in which poor response inhibition, but not set-shifting, provided a unique contribution, beyond temperament, in the explanation of externalizing behavior. This discrepancy may be due, at least in part, to the different ways in which temperament was measured. Martel et al. (2007) assessed two lower order dimensions relevant to Disinhibition, whereas the current study assessed a higher order Disinhibition dimension, likely encompassing a broader, more inclusive space.

Structural equation modeling predicting higher order externalizing behavior jointly examined all domains, as estimated via youth self- and mother-report. These analyses revealed significant unique effects for temperamental Disinhibition as well as the EF dimensions of Conceptual Flexibility and Inhibition. Consistent with the manifest

level findings, Conceptual Flexibility evidenced a significant negative loading while Inhibition evidenced a significant positive association. At the latent variable level, whereas Inhibition had a weak negative association with externalizing behaviors, once Disinhibition was taken into account, better Inhibition predicted higher levels of externalizing behaviors. That is, externalizing behavior is differentially associated with the part of Inhibition that is not related to temperamental Disinhibition. One potential interpretation of this suppressor effect may be that once temperamental Disinhibition is accounted for, the remaining variance of neuropsychological Inhibition may be an indicator of a form of "functional impulsivity" (Dickman & Meyer, 1988), which is the tendency to engage in rapid, error-prone information processing (Dickman, 1990). This strategy, which manifests itself in acting with little forethought, results in the use of strategies that are faster and less accurate (Dickman & Meyer, 1988). Although this strategy often times is problematic, it can result in superior performance depending on the nature and demands of the task. When one considers the scoring of the D-KEFS Color-Word and Trail Making Tests, which anchor the neuropsychological Inhibition factor, one sees that scores on these indicators are based solely on time to completion. It is possible that once temperamental Disinhibition is accounted for, only the speed component of Inhibition remains, in which rapid information processing, regardless of accuracy, is required, which is consistent with the notion of "functional impulsivity" and a positive association with externalizing behaviors.

Strengths and Weaknesses

A major strength of the current study is its use of both youth and parent-report. Given that no "gold standard" exists when measuring problem behaviors in youth (De Los Reyes & Kazdin, 2005), it is important that investigations use muti-informant methodologies. Use of both youth self- and parent-report is vital in understanding and identifying variation in developmental psychopathology. The dual-report approach used in the current study allows for an examination of informant-discrepancies, in addition to

structural equation modeling techniques with latent traits being estimated via manifest level indicators from both informants. Another strength of the current study is its use of a typically developing community sample of male youth. Such a sample allows for associations among complex variables to be examined without a plethora of potentially confounding variables.

Nonetheless, the current study is not without limitations. As stated previously, due in part to the cross-sectional, correlational nature of the data, causal conclusions are not possible. Moreover, the study focus is on phenotypic manifestations of executive functioning and personality traits, rather than on underlying neurobiological mechanisms. Thus, the present study examines a structural model rather than a process or etiological model. Another limitation is that data on of age of onset of the problem behavior was not collected. According to Moffitt's (1993) model, early onset conduct disordered individuals tend to exhibit EF deficits, whereas environmental influences tend to characterize individuals with a later onset of conduct disorder. Therefore, relations between EF and externalizing behavior may have been masked by a heterogeneous age of onset of externalizing behaviors. Future research would benefit from not only a longitudinal design, but also from assessment of age of onset of problem behavior.

Additionally, while potentially a strength, this study sample was relatively homogenous (e.g., White, married, college-educated mothers), and some exclusion criteria (e.g., adolescents never held back a grade) also may have restricted sample variability. Whereas this design results in fewer potential confounding variables, the degree of generalizability of results is unclear. Moreover, the resulting restriction of range likely had various limiting effects, including reducing the theoretically possible degree of relations among study variables. Future research would benefit from including a more heterogeneous sample of youth as well as including both males and females exhibiting a range of psychopathological externalizing behaviors. Specifically, the use of a more heterogeneous sample, including youth identified as "at-risk" or youth involved

with the juvenile justice system, is needed to help address the restriction of range issues in the current sample.

Further, the use of a typically developing sample may have restricted the amount of information provided by the D-KEFS. That is, because the D-KEFS was designed for use with patients having neuropsychological difficulties, it has limited sensitivity to detect variation in the normal range, resulting in a ceiling effect when used with normally developing youth. Thus, use of a more "at-risk" sample almost certainly would yield more variable D-KEFS scores, potentiating more robust relations with other study variables. However, it is important to note that despite the restricted range of D-KEFS scores in the current sample, significant relations were found between EF and other study variables (e.g., temperament and externalizing behaviors). Another important consideration to note when considering the current findings is the moderate test-restest reliability of many of the D-KEFS subtests (Delis et al., 2001b). This limits the potential strength of associations between these scores and other constructs. Finally, the use of only questionnaire-based assessment of temperament and behaviors. Future research also would benefit from both multi-method (e.g., observational data) and multi-informant (e.g., teachers) approaches.

Future Directions

Taken together, results of the current study suggest that externalizing behaviors are multifaceted in that they are arise from a combination of factors, including emotional control as indicated by trait temperament and cognitive control as observed via neuropsychological functioning. Such findings are consistent with efforts to develop comprehensive developmental models of psychopathology integrating both affective and cognitive regulatory mechanisms (Nigg & Huang-Pollock, 2003). In addition to the identification of youth at risk to exhibit externalizing behaviors, the individual differences examined in the present study also should be considered in future longitudinal research examining the persistence and desistence of problem behaviors. One example of

such work is the NICHD Early Child Care Research Network (2004) in which investigators are examining mechanisms associated with the persistence of externalizing behavior problems.

Along these lines, future research should consider neuropsychological functioning, temperament and contextual factors jointly in the prediction of externalizing behavior. When individual-differences risk factors are combined with negative environmental influences, an interpersonally negative, externalizing trajectory may be initiated or maintained. Future research should examine interactions between individual differences and contextual factors, such as parenting, as such interactions may exacerbate or buffer the risk of developing problem behaviors. In addition to parenting, other contextual factors, such as exposure to violence, also should be examined, as previous work has shown associations between exposure to violence and various forms of psychopathology (Latzman & Swisher, 2006; Swisher & Latzman, 2008).

Results of the current study also suggest that Disinhibition and NT, or potentially the higher order trait of Alpha (Digman, 1990), as well as the EF dimension of Conceptual Flexibility, may represent promising candidate endophenotypes. Elucidating simpler behavioral phenotypes that are associated with, and coinherited with, a complex behavioral disorder such as externalizing, will make it easier to identify genes and etiological mechanisms that may contribute to the etiology of this spectrum of problem behaviors. Consistent with research already being conducted by Caspi and colleagues (2002), future research should examine the interaction of individual differences and genetic influences as potential moderators of adaptive and maladaptive outcomes.

Lastly, results of the current study must be considered with the bidirectional nature of brain-behavior relations in mind. Brain functioning, manifested both temperamentally and cognitively, may reflect etiological mechanisms associated with externalizing behavior, but it also is important to note that environmental factors and experiences (e.g., trauma; DeBellis, Hall, Boring, Frustaci, & Moritz, 2001), may alter

brain functioning. Thus, future longitudinal work is needed to elucidate the direction of causality, as well as to examine the possibility that variables not measured in this study can account for their observed relations (i.e., the "third variable" possibility inherent in all correlations). Such work should be interdisciplinary in nature and jointly consider developmental, temperamental, neuropsychological, and neurobiological explanations to externalizing behaviors.

Conclusions

As indices of presumed brain functioning, neither temperament traits nor neuropsychological measures of EF alone are sufficient for a comprehensive model of the etiology of externalizing behaviors. As such, the current study examined the triangular relation among trait temperament, EF, and externalizing behaviors in a large community-based sample of male youth. Results indicated that both temperament and EF individually contributed to the prediction of externalizing behavior and that their joint examination provided incremental predictive ability. Taken together, results of the current cross-sectional investigation provide a strong empirical basis from which future multidisciplinary longitudinal work should follow. Specifically, results of the current study suggest that multi-disciplinary longitudinal examinations of trait Negative Temperament and Disinhibition as well as the Conceptual Flexibility and Inhibition dimensions of EF are promising avenues for future work.

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APPENDIX A. TABLE

Table A1. Correlations between D-KEFS Achievement Scores and Externalizing Behavior

	Youth Self Report			Child Behavior Checklist		
D-KEFS Score	RBB	Agg	Ext	RBB	Agg	Ext
Sorting Test: Free Sort	.05	-.09	-.01	-.11	-.04	-.07
Sorting Test: Free Sort Description	-.08	.14	.05	-.06	-.03	-.04
Sorting Test: Sort Recognition	-.07	.12	.04	-.13	**-.20**	**-.19**
Trail Making Test	-.12	.05	-.03	**-.15**	-.07	-.11
Color-Word Test: Inhibition	.01	.11	.07	-.04	-.08	-.07
Color-Word Test: Inhibition/Switching	.13	.13	**.15**	.06	-.00	.02
Twenty Questions Test	.12	**.16**	**.16**	.03	.04	.04
Verbal Fluency Test: Letter Fluency	.05	.09	.08	.10	.06	.08
Verbal Fluency Test: Category Fluency	-.12	-.10	-.13	-.03	.01	-.01
Verbal Fluency Test: Category Switching	.09	.06	.08	-.10	-.07	-.08
Verbal Fluency Test: Category Switching Accuracy	.06	.00	.03	-.14	-.10	-.12

Table A1. (Continued)

D-KEFS Score	Youth Self Report			Child Behavior Checklist		
	RBB	Agg	Ext	RBB	Agg	Ext
Design Fluency Test	.02	-.06	-.03	-.09	-.13	-.13
Tower Test: Total Achievement	-.07	.07	.01	-.10	-.09	-.10
Tower Test: Accuracy	-.02	.01	-.00	-.04	-.09	-.08
Word Context Test	-.09	.04	-.02	**-.31**	**-.20**	**-.26**

Notes. N =174 except for Color-Word Test scores, *N* =173.

Significant correlations are shown in **boldface**.

Correlations of $\geq$|.15| are significant, $p < .05$; $\geq$ |.20|, $p < .01$; $\geq$ |.25|, $p < .001$.

D-KEFS = Delis-Kaplan Executive Function System.

RBB=Rule-Breaking Behavior.

Agg=Aggression.

Ext=Externalizing Behavior Composite.

APPENDIX B.

RA TRAINING SCHEDULE

Research Assistant: _____

Observation of Full Assessment of Volunteers (2 required):

D-KEFS

1. Witness Signature: _____ Date of Completion: _____

2. Witness Signature: _____ Date of Completion: _____

Completion of Full Assessment of Volunteers (2 required):

D-KEFS

1. Witness Signature: _____ Date of Completion: _____

2. Witness Signature: _____ Date of Completion: _____

Observation of Assessment of a Research Participant (at least one required):

D-KEFS

1. Witness Signature: _____ Date of Completion: _____

Completion of Full Assessment of a Research Participant with Supervision (two required):

1. Witness Signature: _____ Date of Completion: _____

2. Witness Signature: _____ Date of Completion: _____

Completion of Training:

_____ _____

Principal Investigator Signature Date

_____ _____

Research Assistant Signature Date