



A Systematic Review of Primary and Secondary Callous-Unemotional Traits and Psychopathy Variants in Youth

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Accepted: 21 September 2020 / Published online: 20 October 2020
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Abstract

Two variants of callous-unemotional (CU) traits and psychopathy have been proposed, referred to as *primary* and *secondary*. Whereas primary variants are thought to be underpinned by insufficient arousal to emotional cues, secondary variants are thought to develop as a coping mechanism in response to trauma exposure. Compared with adult samples, research on primary and secondary variants in children and adolescents under the age of 18 has only emerged in the past decade, and there is ongoing debate with regards to the identification, defining characteristics, and distinct correlates of these variants. The present systematic review synthesizes the current literature on primary and secondary variants in relation to: (1) constructs used to distinguish and define primary and secondary variants; (2) study population characteristics; (3) data analytic techniques to differentiate variants; and (4) differential associations with theoretically relevant indices related to emotional processing, maltreatment, biomarkers, and behavioral outcomes (e.g., substance use, aggression). This is the first systematic review to examine the growing literature on primary and secondary CU and psychopathy variants among youth. Findings support the distinction between youth with primary versus secondary variants and demonstrate that this distinction is related to unique clinical correlates. Recommendations are made for future research in the field.

Keywords Children · Adolescents · Callous-unemotional traits · Psychopathy · Maltreatment

Introduction

Elevated callous-unemotional (CU) traits (e.g., lack of empathy, shallow affect, and uncaring attitude) are associated with a more severe and chronic trajectory of aggressive antisocial behavior. Children and adolescents with high levels of CU traits tend to be less emotionally responsive (e.g., Kimonis et al. 2006), and show indifference to others' emotions, particularly fear (Dadds et al. 2008; Marsh et al. 2011). These core CU traits are considered to be analogous to the affective dysfunction factor of psychopathy as assessed by the Psychopathy Checklist-Revised (PCL-R; Hare 1991), or the youth version of the PCL-R (PCL-YV; Forth and Kosson 2003). The construct of psychopathy is comprised of two or three further dimensions; interpersonal style (e.g., arrogant

and deceitful, narcissistic view of self, and manipulative behavior), and impulsive and irresponsible behavior (Cooke and Michie 2001; Forth and Kosson 2003). The importance of CU traits in predicting future maladaptive outcomes is highlighted by the recent addition, termed 'Limited Prosocial Emotions', in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; American Psychiatric Association 2013) as a specifier to the diagnosis of conduct disorder (CD). The constructs of CU traits and psychopathy are often intertwined as seminal papers from the psychopathy literature helped to form the basis of our understanding of the development of CU traits (Cleckley 1941, 1946). There is ongoing research and debate regarding the overlap and unique contributions of CU traits versus the full measure of psychopathy in youth samples (Salekin et al. 2018). Studies examining the predictive validity of CU traits and psychopathy have shown that psychopathy may be a better predictor of conduct problems (Andershed et al. 2018), whereas CU traits may be more predictive of the emotional deficits (Gillen et al. 2018). In addition, many studies examining CU traits also use full measures of psychopathy, and vice versa. Thus, while we do not equate CU traits with

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psychopathy, they are highly related and the present review reports on both constructs (i.e., CU traits and the broader psychopathy construct) as indicated by each study.

There is a growing body of literature supporting the possibility of multiple developmental pathways to psychopathy. This is known as equifinality, or a common outcome that develops over time from different starting points (Cicchetti and Rogosch 1996). Early in the adult psychopathy literature, Karpman (1941) proposed that psychopathy may result from two distinct etiological pathways. This model has been extended to CU traits in children and adolescents (e.g., Bennett and Kerig 2014; Kahn et al. 2013; Kimonis et al. 2008). According to Karpman (1941), ‘primary’ psychopathy (or CU traits) is a temperamental or genetically based deficit in emotion processing, resulting in a diminished sensitivity to others’ emotional cues. Conversely, ‘secondary’ psychopathy (or CU traits) is conceptualized as an adaptation to environmental factors such as parental rejection, exposure to trauma, and adverse social contexts (Bennett and Kerig 2014; Kahn et al. 2013; Kimonis et al. 2012a). Karpman (1941) argued that those with secondary psychopathy (or CU traits), are characterized by an affective disturbance conditioned by these pathogenic environmental factors. Children with secondary psychopathy (or CU traits) are thought to have been exposed to severe and chronic maltreatment by their caregivers, resulting in their adoption of an emotionally detached “mask” of callousness as a form of coping (Karpman 1941). Porter (1996) additionally postulated that the onset of psychopathy in these children and adolescents represents an adaptive process involving emotional numbing in order to cope with overwhelming interpersonal trauma. Individuals with primary and secondary variants are thought to be phenotypically indistinguishable with respect to observable characteristics of conning, callous, and antisocial behaviors (Karpman 1941). Recent theories have attempted to better explain how CU traits may develop from these different etiologies (Kimonis et al. 2008). The purpose of the present review is to synthesize the evidence related to the distinction between primary and secondary variants among children and adolescents. Henceforth, the term primary and secondary “variants” are used to discuss the topic broadly, unless referring to a specific study that has identified the use of psychopathy or CU traits. To contextualize the evidence for primary and secondary variants, we first review the contemporary models including the role of biology and the development of moral socialization.¹

¹ Our introduction relies on theoretical papers of CU and psychopathy variants; however, we avoid presenting references that would be included in our results.

Etiology of Callous-Unemotional Traits

Historically, studies have focused on investigating the potential biological basis of CU traits and psychopathy (e.g., Vidving et al. 2005), and less research has examined environmental factors. Genetic effects have been found to account for between 42 and 68% of the variation in CU traits (e.g., Blonigen et al. 2005; Larsson et al. 2008). Examining sex separately, Bezdjian et al. (2011) found heritability estimates for CU traits to be $h^2=0.64$ for males and $h^2=0.49$ for females in a sample of 605 twins (age 9–10 years). Further, unique environmental effects were 0.36 for boys and 0.44 for girls, suggesting that genetic factors may play a greater role in the development of CU traits among boys compared with girls for whom environmental factors may be a stronger predictor. In support of the idea that genetic factors contribute significantly to CU traits, some research has focused on the stability of CU traits from early childhood to young adulthood (Frick et al. 2003). These studies found CU traits and associated aggressive behavior to be relatively stable from younger children to adolescence (up to $r=0.71$; Frick et al. 2003), and from adolescence into early adulthood ($r=0.60$; Blonigen et al. 2005). Importantly, studies have shown that the stability in high CU traits is largely due to genetic effects, particularly for males ($h^2=0.78$), but this was not the case for females ($h^2=0.00$; Fontaine et al. 2010). Environmental factors moderately contributed to stability of high CU traits (0.21 and 0.25, respectively for males and females). Although heritability estimates account for a small to moderate proportion of the variation in CU traits, there exists evidence that environmental factors may also account for some of the elevations in CU traits in children and adolescents.

Proposed Model of Primary Variants

The theory of moral socialization is central to contemporary etiological models of CU traits and psychopathy variants (Kimonis et al. 2008), and are most directly relevant to understanding primary variants. Typically, when children commit transgressions (e.g., aggressive behavior), they are met with distress cues from victims (e.g., crying) or with angry or disapproving responses from parents that signal threat of punishment. These distress cues commonly produce anxiety or discomfort in typically developing children (Blair 1995; Eysenck 1964). Children are, therefore, conditioned to desist from aggressive behaviors, as such acts produce an internal unpleasant affective state. Over time, strong emotions of fear and guilt are elicited in the child at the thought of committing a transgression, and this acts as a socializing agent in the absence of a parent or caregiver, or moral socialization (Kochanska 1997). Children with the

primary variant are thought to differ from typically developing children in their lack of intense and unpleasant emotional reaction to their transgressions against others. This is thought to be due to a fearless temperament and deficits in processing emotional stimuli (Kimonis et al. 2008). It has been proposed that this fearless temperament and deficits in emotional processing,² such as emotion recognition, is in part biological given some research showing CU traits to be associated with reduced amygdala and ventromedial prefrontal cortex responsiveness to others distress cues (Blair 2008, 2010). This derails moral socialization because children with the primary variant are insufficiently sensitive to socializing cues from parents and other adults, and as a result an internal motivational system that inhibits aggressive or antisocial behavior does not emerge (Frick and Morris 2004; Kimonis et al. 2008).

The moral socialization model of primary variants emphasizes the developmental disruption of conscience underpinned by deficits in emotional detection, arousal, and processing (Decety 2010). Blair (1999) found that male children scoring highly on CU traits had lower levels of skin conductance and were less responsive to distress cues, compared to those with low CU traits. Likewise, Sharp et al. (2006) found that psychopathic traits in children were associated with low ratings of arousal to unpleasant pictorial stimuli. Individuals scoring high on CU traits show reduced fear-potentiated startle (Fanti et al. 2016), lower autonomic activity when viewing emotionally evocative scenes (de Wied et al. 2012), and reduced amygdala activation while processing fearful expressions (Viding et al. 2012), compared with their low CU counterparts. Although this theory of moral socialization appears to accommodate primary variants, not all youth with CU traits and psychopathy manifest the theorized associated deficits in emotional processing as observed among individuals comprising the secondary developmental pathway.

Proposed Model of Secondary Variants

In contrast to adolescents with the primary variant for whom reduced arousal and responsiveness to distress cues derails moral socialization, those with the secondary variant are thought to experience hyperarousal and acute sensitivity to negative affect, which may also disrupt moral socialization. As this theory is less established in the literature, we turn to seminal papers in the developmental literature to understand this process. Kochanska (1997) argues that children who are

highly sensitive to emotional cues and environmental inputs become overwhelmed by negative affect, which impairs their ability to process socialization cues and disrupts the development of moral socialization. Building on this seminal work, others have similarly argued that warm and responsive caregiving motivates children to respond cooperatively and positively to socialization cues, aiding the development of moral socialization (Thompson 2012). Youth exposed to trauma (i.e., the secondary variant), may, over time, stop relying on their caregiver for socialization cues, which can interrupt the development of moral socialization (Larstone et al. 2018).

A number of factors appear to increase risk for the development of secondary variants. In particular, exposure to caregiver-perpetrated maltreatment or trauma places children at risk for emotion dysregulation, which results in hyperarousal and overwhelming levels of negative affect (Cicchetti 2016). This dysregulation, and overwhelming arousal, disrupts children's ability to process negative emotions, and ultimately derails moral socialization processes (Frick and Morris 2004; Kimonis et al. 2008; Kochanska et al. 2004). The aversive and overwhelming nature of these experiences may lead children to avoid emotional laden contexts and communication, including parental frustration and anger associated with socialization (Frick and Morris 2004). Avoidance, emotional numbing, and inhibition of empathy for others is reinforced because it reduces distress, and provides a mechanism for coping with uncontrollable and traumatic events and environments (Lansford et al. 2006). In other words, emotional numbing and detachment provide a psychological buffer to threatening situations and emotions that traumatized youth cannot otherwise escape (Bennett and Kerig 2014). Although numbing may serve as a protective function in the short term, it may actually increase aggressive and antisocial behaviors in the long term; such that, children's hypersensitivity to threat and punishment is met with increasing emotional detachment, and thus, curtails learning and moral socialization (Porter 1996). Understanding the effect of trauma on the development of CU traits and psychopathy provides insight into the distinct developmental pathways. As treatment aims to target the underlying mechanisms of behavior problems, should there be sufficient evidence for two pathways to primary and secondary variants in the form of hypo- versus hyperarousal, respectively, there may be significant clinical implications.

The Current Review

Although primary and secondary psychopathy have been discussed in the adult empirical literature for well over 20 years (e.g., Poythress and Skeem 2005), research examining primary and secondary CU traits and psychopathy in children and adolescents under the age of 18 has only

² Emotional processing has been used in this literature to describe numerous constructs, including, but not limited to, facial recognition, emotional reactivity, and eye gaze. Thus, we use this term to broadly describe multiple constructs.

emerged in the past decade. Contemporary models suggest at least two pathways to the development of CU traits and psychopathy. The theoretical etiology of youth with primary CU traits and psychopathy is conceptualized as arising from atypical temperamental and biological factors and is characterized by physiological insensitivity and emotional under-arousal (Karpman 1941). In contrast, secondary CU traits and psychopathy are conceptualized as arising from exposure to overwhelming trauma that gives rise to hypersensitivity, hyperarousal, and emotional numbing. However, given the relatively recent conceptualization of primary and secondary variants in youth samples, there is ongoing debate in the field with regards to the identification, defining characteristics, and distinct correlates of the variants. Thus, the overarching objective of the present review is to synthesize the current literature on primary and secondary variants in youth samples, and to assess the state of the evidence for the theoretical models proposed.

Within this overarching goal we propose four research questions. Is there support for the identification of primary and secondary variants? Is there sufficient heterogeneity in the samples to generalize results? Is there support for the theoretical model of multiple etiologies? Is there evidence of differential negative outcomes for primary and secondary variants? To better understand the current literature, this systematic review is organized around four central aims. First, we describe the constructs used to define primary and secondary variants. Second, we provide a summary of the study populations that were included in studies we reviewed. Third, we describe the data analytic techniques to differentiate primary versus secondary variants. Finally, we review differential associations of primary versus secondary variants with theoretically relevant indices related to emotional processing, maltreatment, biomarkers, and behavioral outcomes (e.g., substance use, aggression).

Method

The current study included a systematic review of the literature following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA; Liberati et al. 2009) guidelines. The search included both CU traits and psychopathy, as CU traits are considered a core feature of psychopathy. Including psychopathy in the search was essential, given that many studies relied on a psychopathy scale in order to measure CU traits prior to the development and large scale use of the Inventory of Callous-Unemotional Traits (ICU; Frick 2004). Three databases were searched: PsycINFO, MEDLINE, and PubMed. Keywords included (“primary AND secondary” OR “variant”) AND (“callous-unemotional traits” OR “psychopathy”) AND (child* OR adolescen* OR youth). Publications were restricted to peer

reviewed journal articles. We included articles published prior to December 2019, no language restrictions were imposed. We did not impose a start date as most studies in this area have been published in the past 12 years. A thorough review of all references was also included to ensure no studies were missed during the initial search process. The search identified a total of 396 records (see Fig. 1 for PRISMA flowchart), 125 of which were deleted as duplicates. An additional six records were found outside of the original search by reviewing reference sections from each article, as well as from an ongoing Google Scholar alert using the key phrase “CU variants” and were subsequently included in the review. These additional records often used slightly different terminology (e.g., CU ‘features’ instead of ‘traits’) which would have resulted in their exclusion from the original search. As some scholars are opposed to the word “traits”, it was important to keep an ongoing search to ensure all appropriate papers were included.

Articles were first uploaded into Endnote version X7.8 from the databases and then downloaded into Covidence (Mavergames 2013). Covidence is an online systematic review management system that allows for the systematic screening of abstracts and full-text articles (Mavergames 2013). Using the Covidence program, first titles and abstracts were reviewed by two independent reviewers for the following criteria: (1) age criteria was limited to those under 18 years of age; and, (2) the study evaluated the concept of primary and secondary CU or psychopathy variants. Interrater reliability for the abstract review was good ($\kappa=0.75$). When there were disagreements with regards to which articles should be included, reviewers discussed and decided together whether the article should go to full-text review. Of the 277 abstracts reviewed, 60 were included for full-text review. At the full-text review level, articles were excluded if they: used age groups outside children or adolescence (e.g., undergrads; $k=11$), there was no mention of primary/secondary CU traits or psychopathy in their results section ($k=7$), or the paper was a dissertation ($k=1$). Based on the full-text reviews 41 articles were selected for data extraction and summary.

Data extraction included populations, how primary and secondary variants were identified, measures used in the study, and the main findings. Articles were coded for population type (justice-involved, community, clinical), method (cluster, median or tertile split, or Latent Profile analysis [LPA]), gender or sex of sample (male only, female only, both genders), and whether the paper used a measure of CU traits or psychopathy. Articles were grouped by the main outcomes. The current review is organized into four sections, coinciding with the research aims. First, the constructs used in the studies to define the two variants are described. Next, the study population samples are described. Third, we review the analytic techniques in studies. Finally, we

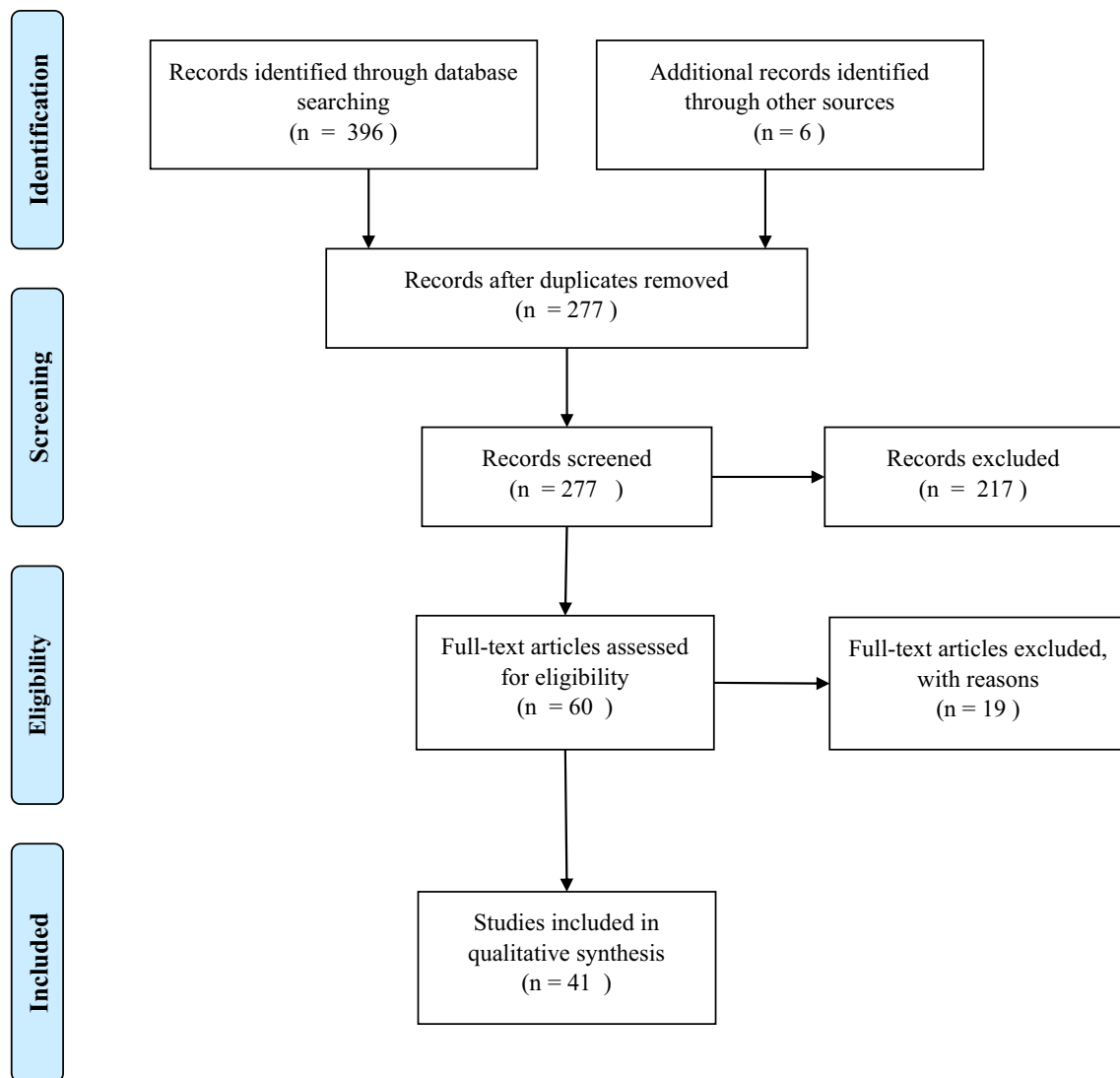


Fig. 1 PRISMA flowchart for review process

review results pertaining to theoretically relevant validating variables are examined including exposure to maltreatment, emotional processing, biomarkers, and behavior outcomes.

Results

Constructs Used to Define Primary and Secondary Variants

Table 1 provides a summary of constructs used in each of the 41 studies that identified youth as being primary and secondary variants. By far the most common strategy used to define primary or secondary variants was the inclusion of a measure of anxiety ($k=34$) along with a measure of CU traits ($k=24$) or psychopathy ($k=17$).

CU Traits/Psychopathy

Of the 24 articles that referred to CU traits, 13 relied on the ICU, six used the CU scale in a measure of psychopathy such as the Youth Psychopathic Traits Inventory (YPI; Andershed et al. 2002) or the Antisocial Process Screening Device (APSD; Frick and Hare 2001). Three studies used a collection of items from the Child Behavior Checklist (CBCL; Achenbach 2009), or a combination of different scales, referred to as the University New South Wales (UNSW) method. Of the 17 articles that referred to primary and secondary psychopathy throughout their paper, six used measures of CU traits, including the ICU (Frick 2004) as their measure of psychopathy, while the remaining 11 relied on either parent or self-report (e.g., YPI, Andershed et al.

Table 1 Measures used to define CU and psychopathy variants

‘Psychopathy’ studies							
Author	Psychopathy	CU traits	Anxiety	Trauma/ Mal-treatment	Aggression	PTSD	Other
Bjørnebekk and Gjesme (2009)							Levenson’s primary/secondary scale
Colins et al. (2018)	YPI		✓				
Docherty et al. (2016)		ICU	✓				
Fanti et al. (2020)		YPI- CU	✓	✓			
Fragkaki et al. (2019)		ICU		✓			
Gill and Stickler (2016)	ASPD: N	ICU	✓				BIS, BAS, sensation seeking, empathy
Huang et al. (2020)		UNSW System	✓		✓		
Hicks et al. (2012)							MPQ Factor 1 and 2
Kimonis et al. (2012a)	YPI		✓				
Kimonis et al. (2017b)		ICU	✓		✓		
Kimonis et al. (2011)	PCL-YV		✓				
Kimonis et al. (2012b)	YPI		✓				
Lee et al. (2010)	PCL-YV APSD		✓				
Tatar et al. (2012)	YPI		✓			✓	
Vaillancourt and Brittain (2019)							ASPD Factor 1 and 2
Vaughn et al. (2009)	APSD		✓				Psychopathology
Veen et al. (2011)	YPI		✓				
Waller and Hicks (2019)	PCL-YV		✓				
Wareham et al. (2009)	YPI						Internalizing and externalizing broad-band scales
Zwaanswijk et al. (2018)	YPI		✓				
‘CU Traits’ studies							
Author	Psychopathy	CU traits	Anxiety	Trauma	Aggression	PTSD	Other
Bennett and Kerig (2014)		ICU				✓	
Craig and Moretti (2019)		ICU	✓	✓			Dysregulation/suppression
Dadds et al. (2018)		UNSW System	✓	✓			
Euler et al. (2015)		YPI- CU	✓				
Ezpeleta et al. (2017)		ICU	✓				ODD symptoms
Fanti et al. (2013b)		ICU	✓		✓		
Fanti et al. (2018)		ICU	✓		✓		
Fanti and Kimonis (2017)		CBCL	✓		✓		
Flexon (2015)		YPI- CU	✓				
Flexon (2016)		YPI- CU	✓				
Goulter et al. (2017)		APSD- CU	✓				
Humayun et al. (2014)		ASPD- CU	✓				
Kahn et al. (2017)		ICU	✓				
Kahn et al. (2013)		APSD- CU	✓	✓		✓	
Kimonis et al. (2013b)		ICU	✓	✓			
Kimonis et al. (2017a)		ICU		✓	✓		
Kimonis et al. (2008)		ICU	✓				Community violence
Meehan et al. (2017)		ICU- IC	✓				
Robertson et al. (2018)		ICU	✓				
Roşan et al. (2015)		ICU	✓				
Sharf et al. (2014)		ICU	✓				

APSD Antisocial Process Screening Device, CBCL Child Behavior Checklist, CU Callous-unemotional, ICU Inventory of Callous-Unemotional Traits, IC Interpersonal callousness, N Narcissism, PCL-YV Psychopathy Checklist-Youth Version, YPI Youth Psychopathy Inventory, UNSW (University of New South Wales)

2002) or clinician rated scales (e.g., PCL-YV, Forth and Kosson 2003) of the broader psychopathy construct.

In the studies that used psychopathy scores, six examined differences across the various factors of psychopathy (e.g., CU traits, interpersonal, antisocial behavior). Of those, four studies found no difference in CU traits, but significant differences in at least one other factor of psychopathy (Kimonis et al. 2011, 2012a; Tatar et al. 2012; Waller and Hicks 2019). Two studies found secondary variants to score lower on CU traits but similar on other aspects of psychopathy (Gill and Stickle 2016; Veen et al. 2011).

Anxiety

The majority of articles ($k=34$) stated they used an anxiety scale in their differentiation of the variants. Some studies relied on scales that exclusively measured anxiety such as the Revised Children's Manifest Anxiety Scale (Reynolds and Richmond 2008), others used a scale that combined anxiety into broader internalizing scales such as the anxious-depressed scale on the CBCL, or the Achenbach Youth Self-Report (Achenbach 1991). One study used a broad measure of internalizing problems called the Comprehensive Adolescent Severity Inventory (CASI; Meyers 1996).

Abuse/Maltreatment/Trauma

Seven studies used a measure of exposure to abuse, maltreatment, or trauma in distinguishing the CU variants. These measures included broad trauma and specific maltreatment by parents (see trauma outcome section for more details). In addition, three studies used trauma symptoms in defining the variants.

Other Measures

Other measures used to define the variants included behavior inhibition, behavior activation, sensation seeking, empathy (Gill and Stickle 2016), numerous indicators of psychopathology (i.e., depression, phobic anxiety, somatization, interpersonal sensitivity, obsessive compulsive disorder (OCD), and paranoia, suicidal ideation, attention-deficit/hyperactivity disorder (ADHD) diagnosis, and prescribed anti-depressants; Vaughn et al. 2009), and affect dysregulation and suppression (Craig and Moretti 2019).

Alternate Definitions

Three studies used an alternative definition and measure for youth with primary and secondary variants, differentiating them based on psychopathy factor one (i.e., deficient affect) and factor two (i.e., impulsive antisocial behavior). Bjørnebekk and Gjesme (2009) used Levenson's scale of

primary and secondary psychopathy, which defined primary psychopathy as "selfish, uncaring, and manipulating posture towards others" (Levenson et al. 1995, p. 152), and secondary as "impulsivity, and self-defeating lifestyle" (Levenson et al. 1995, p. 152). Hicks et al. (2012) utilized the Multidimensional Personality Questionnaire (MPQ; Tellegen and Waller 2008) that, similar to Levenson's scale defined Factor 1 as fearless dominance, and Factor 2 as impulsive antisocial. Likewise, a third paper used the APSD CU traits and impulsivity scales (Vaillancourt and Brittain 2019). In all three papers, the authors argued that Factor 1 (i.e., the CU traits dimension) represented primary psychopathy and Factor 2 (i.e., the impulsivity dimension) represented features of secondary psychopathy. It should be noted that measures of psychopathy used by other studies in this review also measure psychopathy on at least two dimensions (e.g., PCL; Hare 1991); however, all other studies included the affective dimension (CU traits) in their definition of psychopathy. As the definition of primary and secondary psychopathy differed greatly in these three studies, in comparison to other studies included in the review, they were removed from further summarization; however, these results are included in Table 2.

Primary and Secondary Variants Study Populations Characteristics

Table 2 summarizes the sample characteristics and main findings from each of the 41 studies. Just over half of the studies ($k=24$, 58.5%) included justice-involved adolescent samples. Participants in about a third of the studies ($k=16$) were justice-involved male youth. About half ($k=25$, 60.9%) of the studies included a mixed gender sample. Ethnicity of the samples varied. Studies that examined community and clinical samples were primarily Caucasian, while justice-involved samples had higher rates of Black and Hispanic youth comparatively.

Data Analytic Methods Applied to Differentiate Primary and Secondary Variants

As summarized in Table 2, most studies ($k=28$) examined primary and secondary variants through clustering models. Specifically, 9 studies used clustering methods and 19 studies used mixture models (e.g., latent class analysis [LCA], LPA, growth mixture models). Of those that used cluster or mixture model analyses, seven studies applied these analytic techniques only to data from youth high on CU traits or psychopathy. For example, a series of studies used the clinical cutoff on the PCL-YV (i.e., 27; Kimonis et al. 2011), or a score on the YPI that corresponds to the PCL-YV cutoff (i.e., 121.5; Kimonis et al. 2012a, b; Tatar et al. 2012). Other methods included using the top third of the ICU (Bennett

Table 2 Summary of each study in the review

Author	Population	Methods	Results
Bennett and Kerig (2014)	$N = 417$; $M_{age} = 16.15$; justice-involved; 73.4% male; US, 57.6% White, 24.0% Hispanic/Latino	LPA of top third of ICU scores	Acquired (secondary) variant reported higher levels trauma exposure and were more accurate in identifying others disgust, more non-acceptance of emotions, lack of clarity regarding their emotional states and more emotional numbing
Bjornebekk and Gjessme (2009)	$N = 158$; $M_{age} = 15.1$; high-risk; 65.8% male; Norway	Levenson's primary/secondary scale	Primary was correlated with BAS and negatively to BIS, secondary correlated to BAS. Both negatively correlated with future time orientation. Low BIS and low future time orientation = higher primary
Colins et al. (2018)	$A, N = 847$; $M_{age} = 16.7$; $B, N = 749$, $M_{age} = 17.02$; justice-involved; 100% male; Netherlands	LPA	Found a high and moderate psychopathy group. Unable to identify secondary using a simple model with psychopathy and ANX, or with a more complex model adding depressed mood, anger-irritability, and maltreatment
Craig and Moretti (2019)	$N = 418$; $M_{age} = 15.04$; clinical; 43.3% male; Canada, 65.3% White, 8.7% Aboriginal, 6.6% Asian	LPA	Secondary higher on affect dysregulation, affect suppression, ANX, maltreatment by parents, as well as ADHD, CD, depressive symptoms. Variants identification did not differ by gender. More boys than girls classified as primary
Dadds et al. (2018)	$N = 364$; $M_{age} = 8.93$; clinical; 72% male; Australia, 64.6% Caucasian	Moderated regression	Maltreatment moderated the effect of CU traits on emotion recognition such that poor emotion recognition skills were associated with CU traits at low levels of maltreatment, representing primary. ANX did not moderate the effect of CU traits on emotion recognition
Docherty et al. (2016)	$N = 799$; $M_{age} = 16$; justice-involved & community; 59.9% male; US, 53.7% White, 38.2% Black	Cluster	Secondary higher on depression, psychoticism, violence, aggression, and exposure to neighborhood violence
Ezpeleta et al. (2017)	$N = 622$; $M_{age} = 3.77$; community; 50.1% male; Spain	Growth mixture model	Secondary had a more severe clinical picture with difficulties in EF, environmental characteristics, and outcomes (negative affectivity, lability, aggression, sensitivity, psychopathology) compared to primary
Euler et al. (2015)	$N = 158$; $M_{age} = 15.61$; justice-involved; 69% male; Switzerland	Two-step cluster	Secondary scored higher on depressed/anxious, angry/irritable, traumatic experience, delinquent behavior, attention problems, harm avoidance, and cooperativeness, but not alcohol/drug use
Fanti et al. (2013)	$N = 2306$; $M_{age} = 16$; community; 50.3% male; Cyprus	LPA	Primary scored higher on self-esteem; secondary higher on narcissism, reactive aggression, peer pressure, and popularity striving. Both CU groups scored higher on disinhibition, boredom susceptibility, sensation seeking, and proactive aggression, than controls. Boys more likely to be primary and secondary

Table 2 (continued)

Author	Population	Methods	Results
Fanti and Kimonis (2017)	<i>N</i> = 834 -957; follow-up at age 6-15; community; 51.7% male; US, 77.5% White, 11.7%, 11.7% African American	LPA	Age 15 outcomes: Secondary had higher heart rate and lower cortisol concentrations; secondary had more trouble with self-regulation, and lower cognitive and achievement scores Primary showed lower right amygdala activity in response to neutral male faces. Participants with a history of abuse exhibited higher right amygdala activity during threat acquisition, compared with all other groups. During threat extinction, the primary showed lower right amygdala activity compared to the secondary and the abuse group
Fanti et al. (2020)	<i>N</i> = 136; <i>M</i> _{age} = 17.7; justice-involved; 86% male; Netherlands	LPA	Secondary and anxious group showed higher physiological arousal and startle reactivity to violent, fearful, and anger stimuli, compared with primary. Primary and secondary showed similar physiological reactions to sad stimuli assessed during childhood. Additionally, both primary and secondary showed lower medial prefrontal cortex activation to violent stimuli compared to the anxious group
Fanti et al. (2018)	A: <i>N</i> = 88; <i>M</i> _{age} = 19.92; community; 50% female; B: <i>N</i> = 72; <i>M</i> _{age} = 5.78; community; 39% male; Cyprus	LPA (A); 1 SD above or below on CU traits, conduct problems and ANX (B)	Primary showed no relationship with parenting. Parent monitoring and supervision had negative relationship with secondary youth. Parent hostility had a relationship with secondary youth Secondary engaged in more instrumental violence and reactive aggression than non-CU youth; both primary and secondary more likely to be reactive than non-CU youth
Flexon (2015)	<i>N</i> = 183; community; age 15; approx. 50% male; US, 80% White	1 SD above the mean on ANX and CU	Found a significant interaction between CU traits and emotional neglect on mean daily oxytocin, participants with high CU traits and low emotional neglect (primary) exhibited lower daily oxytocin secretion compared to high CU traits and high levels of emotional neglect (secondary) Secondary higher on interpersonal reactivity, behavior inhibition, behavior activation, and ANX; primary higher on antisocial screening, CU traits, narcissism, sensation seeking. More boys in primary, more girls in secondary
Flexon (2016)	<i>N</i> = 183; community; age 15; approx. 50% male; US, 80% White	1 SD above the mean on ANX and CU	Found stable primary and secondary from age 7 to 15. Secondary experienced harsher parental punishment, greater depression and lower self-control at age 7, and had poorer mental health outcomes at age 16
Fragkaki et al. (2019)	<i>N</i> = 57; <i>M</i> _{age} = 17.95; residential care; 100% male; Netherlands, 82.5% Dutch	Moderated regression	
Gill and Stickle (2016)	<i>N</i> = 150; <i>M</i> _{age} = 15.2; justice-involved; 60% male; US, 85% White, 5% Hispanic	LPA	
Goulter et al. (2017)	<i>N</i> = 1829; follow-up from age 7 to 15; high-risk; 100% female; US, 53% African American, 41% European American	LCGA	

Table 2 (continued)

Author	Population	Methods	Results
Hicks et al. (2012)	$N = 2604$; $M_{age} = 17.83$; community; twin study; 47.6% male; US, 96% non-Hispanic White	Multidimensional personality questionnaire (MPQ)	MPQ- Impulsive Antisociality (i.e., secondary) related to environmental risk factors including family, peer, school and stressful life events. MPQ-fearless dominance (i.e., primary traits) was not. Both MPQ IA and FD were heritable
Huang et al. (2020)	$N = 1861$; $M_{age} = 9.22$; community; 52.4% male; China	LPA	Secondary had higher levels of conduct problems and ANX. More males than females in both variant groups; however, found no gender differences on levels of CU traits, ANX, or aggression within groups
Humayun et al. (2014)	$N = 3974$; age 4 predictor, age 7 outcome; twin community sample; 48% male; UK	Primary scored at least 1.35 SD above mean on CU; less than 1.49 SD on ANX; secondary high on both	High levels of CU with and without ANX were influenced by genetics, with negligible effects of shared environment. No difference in parenting characteristics between groups at both 4 and 7 years of age. More peer problems and antisocial behavior in CU + ANX group
Kahn et al. (2017)	$N = 107$; $M_{age} = 15.50$; justice-involved; 100% male; US, 79% African American, 14% Caucasian	Moderated regression	Reduced accuracy of identifying disgust faces at high levels of ANX and CU traits. CU traits negatively correlated with cognitive empathy at higher levels of ANX. No CU \times ANX moderation for facilitation to distress
Kahn et al. (2013)	$N = 300$; $M_{age} = 13.40$; clinical; 51% male; US, 90% African American	Two-step cluster	Secondary youth had higher levels of aggression, cruelty, externalizing problems, impulsivity, behavior inhibition, and behavior activation compared to primary youth
Kimonis et al. (2017a)	$N = 238$; $M_{age} = 16.8$; justice-involved; 100% male; US, 42% Caucasian, 36% African American	LPA	Secondary had enhanced aversive startle potentiation relative to primary and non-psychopathic controls
Kimonis et al. (2013b)	$N = 227$; $M_{age} = 15.73$; justice-involved; 100% male; US, 44.1% African American, 38.8% Caucasian	LPA	Secondary had higher levels of sexual abuse but not emotional, or physical. Primary had higher levels of emotional and physical neglect
Kimonis et al. (2012a)	$N = 373$; $M_{age} = 16.42$; justice-involved; 100% male; US, 53% Hispanic, 29% African American	Cluster on youth scoring above 121.5 on YPI	High anxious secondary endorsed more negative emotionality, and childhood abuse than low anxious primary. Secondary more engaged by distressing emotional stimuli than primary
Kimonis et al. (2008)	$N = 88$; $M_{age} = 15.57$; justice-involved; 100% male; US, 68% African American, 23% Caucasian	Moderated regression	Those high on CU traits and exposure to violence showed less facilitation to distressing stimuli. Those with high CU and low levels of violence exposure showed enhanced facilitation to distress and higher levels of abuse. Higher levels of abuse linked to enhanced facilitation of distress

Table 2 (continued)

Author	Population	Methods	Results
Kimonis et al. (2017b)	$N = 232$; $M_{age} = 16.75$; justice-involved; 100% male; 41.8% Caucasian, 35.3% African American	LPA	Secondary and highly aggressive primary had higher levels of abuse and maltreatment compared to low aggressive primary. Secondary had higher levels of PTSD symptoms and distinct high cortisol-to-DHEA ratios. Both primary groups showed high DHEA levels relative to other groups. No difference on cortisol levels across variants
Kimonis et al. (2011)	$N = 116$, $M_{age} = 15.82$, justice-involved; 100% male; US, 42% Black, 35% White	Cluster on youth scoring in psychopathic (≥ 27) range	Secondary more psychosocially immature and at greater risk for institutional violence that is more reactive. Secondary also had greater variety of institutional violence. Secondary variants more reactive, defensive, and emotional. Secondary variants had higher abuse history
Kimonis et al. (2012b)	$N = 373$; $M_{age} = 16.42$; justice-involved; 100% male; US, 53% Hispanic, 29% African American	Cluster on youth scoring above 121.5 on YPI	Secondary reported higher levels of maltreatment, psychopathology, and pre-incarceration substance use, including alcohol use and other drug use. Odds of using substances and diagnosed with substance use disorder while incarcerated where twice as high for secondary youth
Lee et al. (2010)	$N = 94$; $M_{age} = 15.21$; justice-involved; 100% male; US, 53% African American, 46% Caucasian	Cluster	“High” group had high psychopathy and high ANX; “Med” group had medium psychopathy and low ANX. High group had low positive personality traits and a higher risk of dangerousness. Both groups were risk takers
Meehan et al. (2017)	$N = 6791$; follow-up age 2–13, community; 50% male; England	Cluster	Interpersonal callousness/ANX + group (secondary) had highest risk exposure for all environmental exposures except harsh parenting (not significant than Interpersonal callousness/ ANX-)
Robertson et al. (2018)	$N = 1216$; $M_{age} = 15.29$; justice-involved; 100% male; US, 45.9% Hispanic, 36.9% African American	Moderated regression	ANX moderated the effect of CU traits on violent offending such that youth with high levels of both CU traits and ANX, representing the secondary, had higher levels of self-reported total offending
Roşan et al. (2015)	$N = 125$; $M_{age} = 16.78$; justice-involved; 100% male; Romania	Mean split on ICU and ANX	Secondary had higher levels on all types of aggression (reactive overt and relational, proactive overt and relational), impulsivity, narcissism, anger/irritable, somatic complaints, suicidal ideation, thought disturbances. Primary higher than low youth on proactive relational aggression
Sharf et al. (2014)	$N = 238$; $M_{age} = 16.8$; justice-involved sample; 100% male; US, 59.1% Caucasian, 33.2% African American	Tertile split on CU, median split on ANX	High CU related to higher negative life events, more PTSD symptoms in arousal and avoidance. Secondary reported more PTSD symptoms than low ANX

Table 2 (continued)

Author	Population	Methods	Results
Tatar et al. (2012)	$N = 373$; $M_{age} = 16.42$; justice-involved; 100% male; US, 53% Hispanic, 29% African American	Cluster on youth scoring above 121.5 on YPI	Secondary had higher trauma history (30% more), and greater past PTSD symptoms; no difference on current PTSD symptoms. Secondary 2.5 times more likely to report a past dissociative experience than comparison but no difference to primary
Vaillancourt and Brittain (2019)	$N = 572$; Collected in grade 8–12; community; 55.7% male; Canada, 70.6% Caucasian	CU and Impulsivity scale from ASPD	Impulsivity (secondary traits) correlated with ANX currently at each age but not longitudinally. Low ANX correlated both concurrently and longitudinally with high CU traits (primary traits). BPD features correlated concurrently and longitudinally with impulsivity (secondary traits) but not CU traits (primary traits)
Vaughn et al. (2009)	$N = 267$; $M_{age} = 15.43$; justice-involved; 86.1% male; US	Mixture model with $N = 132$ above 1 SD on the APSD	Secondary had higher exposure to trauma and post trauma symptoms. Secondary had higher drug use, total self-reported delinquency, violent offending, property offending, and criminal victimization than primary group
Veen et al. (2011)	$N = 299$; age 12–18*; justice-involved; 100% male; Netherlands, 47% Moroccan	LCA on high psychopathic group sample	High anxious psychopathic (secondary) scored lower on the affective factor of psychopathy and higher on measures of externalizing problems, withdrawn, attention, thought, and social problems. They also reported higher levels of substance use than primary
Waller and Hicks (2019)	$N = 1170$; $M_{age} = 16.05$; justice-involved; 100% male; US, 42% African American, 34% Hispanic-American	LCA	No difference between variants on self-reported offending, suppression of aggression, or consideration of others. Secondary higher on ANX, depression, poor impulse control, and PTSD compared to primary. No difference on levels of alcohol or marijuana use. Indirect relationship of secondary to alcohol and marijuana use via poor impulse control
Wareham et al. (2009)	$N = 165$; $M_{age} = 14$; justice-involved; 52.1% male; US, 61% Caucasian, 33% African American	LCCA	Did not find two variants, rather found a primary group, an impulsive-anxious group, impulsive group and a non-psychopathic group
Zwaanswijk et al. (2017)	$N = 2874$; $M_{age} = 14.47$; community; 57% male; Netherlands, 55% Dutch, 10% Moroccan-Dutch	LPA	Secondary scored higher on emotional problems, conduct problems, hyperactivity, peer issues, prosocial behavior and self-esteem. Non-western immigrant participants more likely to be in the secondary group

ADHD Attention-Deficit/Hyperactivity Disorder, ANX anxiety, BAS Behavioral Activation System, BIS Behavioral Inhibition System, BPD Borderline Personality Disorder, CD Conduct Disorder, CU Callous-unemotional traits, DHEA Dehydroepiandrosterone, EF Executive Functioning, ICDU Inventory of Callous-Unemotional Traits, LPA Latent Profile Analysis, LCCA Latent Cluster Class Analysis, LCGA Latent Class Growth Analysis, ODD Oppositional Defiant Disorder, PTSD Post-traumatic Stress Disorder, YPI Youth Psychopathy Inventory

For ease of communication in the table, we have just referred to primary and secondary CU variants as “primary” and “secondary”, respectively

*Mean age not provided

and Kerig 2014), using those who were high on psychopathy using a latent class analysis (LCA; Veen et al. 2011), and using one standard deviation above the mean on the ASPD (Vaughn et al. 2009) as the cutoff point. The remaining 21 studies applied the cluster analysis to the full sample. Other analytic strategies of differentiating primary and secondary variants included mean or tertile splits on CU traits and anxiety (Ezpeleta et al. 2017; Rosan et al. 2015; Sharf et al. 2014). Flexon (2015,2016) defined secondary CU traits based on youth scoring 1 standard deviation above the mean on CU traits and ‘dichotomizing’ anxiety; however, it was unclear what the cutoff point was for anxiety in these two studies.

Beyond the use of clustering methods, five articles used an interaction between CU traits and anxiety or exposure to violence in moderated regressions to examine the construct of primary and secondary variants. This methodology allowed the authors to examine the combination of high levels of CU traits and either anxiety or exposure to trauma or abuse as a proxy for secondary CU traits.

Proportion of Variants

Of those studies that used a grouping technique (e.g., LPA, mean split), the proportion of primary and secondary variants varied greatly. Overall, the rate of primary variants ranged from 4.2 to 40.7%, and secondary variants ranged from 1.2 to 30%. When compared across populations sampled, the rates were slightly higher for justice-involved samples compared to community or clinical/high-risk samples. For justice-involved samples, the rate of primary variants ranged from 13 to 40.7% and secondary variants ranged from 4.2 to 30% (Bennett and Kerig 2014; Docherty et al. 2016; Euler et al. 2015; Fanti et al. 2020; Kimonis et al. 2017a; Rosan et al. 2015; Vaughn et al. 2009; Veen et al. 2011; Waller and Hicks 2019). In community-based samples, the rate of primary variants ranged from 5 to 32.9%, while the rate of secondary variants ranged from 1.2 to 15% (Ezpeleta et al. 2017; Fanti et al. 2013; Fanti and Kimonis 2017; Flexon 2015, 2016; Huang et al. 2019; Humayun et al. 2014; Meehan et al. 2017; Zwaanswijk et al. 2018). The rate of primary variants in high-risk or clinical samples ranged from 11 to 28.3%, while secondary variants ranged from 6.5 to 30.3% (Craig and Moretti 2019; Goulter et al. 2017; Kahn et al. 2013). Examining the average rates for each population, primary variants were the highest in the justice-involved sample (26.1%), compared to clinical/high-risk (19.5%), or community (12.5%) ($F(2, 28) = 8.35, p \leq 0.001$). Rates of secondary variants were highest in clinical samples (21.1%), compared to justice-involved samples (15.9%) or community (7.9%) ($F(2, 28) = 8.35, p < 0.001$). The rate of primary and secondary variants did not differ for studies that

used CU traits or psychopathy ($t(29) = 1.45, p > 0.05$ and $t(29) = -1.08, p > 0.05$, respectively).

There were some differences for the average rate of primary variants across methodology. Studies using a two-step cluster method have higher average rates of primary variants (27.2%), compared to LPA or median/tertile split (17.8% and 10.9%, respectively) ($F(2) = 7.21, p < 0.01$). Using the cutoff method (i.e., only using youth scoring above clinical cutoff on PCL-YV) also resulted in higher average rates of primary variants (29.4% for cutoff vs. 18% for studies not using a cutoff) ($t(29) = -2.80, p < 0.01$). The average rate of secondary variants did not differ across methodologies.

Gender Differences in Rates of Primary and Secondary Variants

Of the 21 studies that included both males and females in the sample, nine did not report on gender or sex differences.³ In the remaining 12 studies, the proportion of males and females across the variants were inconsistent. Overall, the average rate of primary variants was higher for all male samples (26.3%) compared to samples using mixed genders (17.8%) ($t(28) = -2.28, p < 0.05$). There was no difference in the average rates of secondary variants across gender (13.5% male only vs. 13.0% mixed gender). Six studies found a higher proportion of males in the primary variant (Craig and Moretti 2019; Euler et al. 2015; Fanti et al. 2013; Flexon 2015; Huang et al. 2020; Zwaanswijk et al. 2018); however, six studies did not find a difference in the proportion of males and females in the primary variant (Docherty et al. 2016; Gill and Stickle 2016; Kahn et al. 2013; Meehan et al. 2017; Vaughn et al. 2009). Three studies found a higher proportion of females in the secondary variant (Docherty et al. 2016; Euler et al. 2015; Gill and Stickle 2016), three studies found a higher proportion of males in the secondary variant (Fanti et al. 2013; Huang et al. 2020; Zwaanswijk et al. 2018), while the other six remaining studies did not find a gender difference. The population samples (i.e., justice-involved, community, clinical) did not determine gender differences. Only one study examined an exclusively female sample (Goulter et al. 2017).

Beyond examining the proportions within the groups, little research has been conducted on gender or sex differences among primary and secondary variants. One study found that gender did not moderate the relationship between variant type and differences in affect, meaning that boys and girls in the secondary psychopathy group were just as likely to have greater negative affect than those in the primary group (Gill and Stickle 2016). The authors of this study did

³ As Flexon, 2016 used the same sample as Flexon, 2015 it was removed from this summary to avoid bias.

note that this finding underscored the “significance of affective difference between the psychopathy variants in youth, as they persisted beyond the influence of gender” (Gill and Stickle 2016, p. 304). Finally, one study examined the CU variants more extensively across gender, in addition to gender invariance across the groups (Craig and Moretti 2019), and found invariance for the identification of groups and the indicators within the groups including affect dysregulation and suppression, lending support to Gill and Stickle’s (2016) affective results.

Theoretically Relevant Validating Variables for Primary and Secondary Variants

Abuse and Post-traumatic Stress Disorder Symptoms

Over half of the studies in the review ($k=22$) examined exposure to abuse/trauma and/or post-traumatic stress disorder (PTSD) symptoms in youth with primary and secondary variants. Three of these studies used trauma or abuse as a moderator, including exposure to community violence (Kimonis et al. 2008), maltreatment (Dadds et al. 2018), and emotional neglect (Fragkaki et al. 2019). The remaining studies ($k=19$) used clustering methods. Of the studies that measured exposure to abuse/trauma ($k=18$), five studies used exposure to abuse or trauma as a clustering variable, while 15 studies used abuse/trauma as an outcome or validating variable.⁴ Whether used as a cluster variable or a validating variable, the majority of studies ($k=15$, 83.3%) found those identified as secondary variants reported higher rates of abuse/trauma or adverse childhood experiences, compared to those identified as primary variants and controls.⁵ This was the case for measures of broad trauma exposure (e.g., different types of traumatic events; Bennett and Kerig 2014; Sharf et al. 2014; Tatar et al. 2012), specific maltreatment by parents (e.g., parental absence, domestic violence, physical, emotional and sexual abuse; Craig and Moretti 2019; Fanti et al. 2020; Goulter et al. 2017; Kimonis et al. 2012a), as well as family adversity, harsh parenting, and maternal psychopathology (Meehan et al. 2017). The remaining three studies had mixed results. Kimonis et al. (2013b) used several forms of abuse (e.g., physical, emotional, sexual) in their LPA model, and found higher rates of sexual abuse but not emotional or physical abuse in youth with secondary CU traits. In contrast, youth with primary CU traits were found to have higher rates of emotional and

physical neglect in this study. This study included all types of abuse in their LPA of primary and secondary CU traits. They also included three indicators of anxiety (i.e., physiological, worry, social concerns), as well as the three factors of CU traits (i.e., uncaring, unemotional, callousness). The majority of other studies use one indicator of anxiety and CU traits. Another study identified variants earlier in development at age 7 using CU traits and anxiety, and did not find differences in harsh parenting (e.g., physical punishment) at age 3 (Humayun et al. 2014). Finally, Kimonis et al. (2017b) identified variants with CU traits, anxiety, and aggression, and did not find a significant difference in rates of abuse between youth with highly aggressive primary and secondary CU traits. The authors did find youth with highly aggressive primary and secondary CU traits had more trauma exposure than youth with non-aggressive primary CU traits.

Importantly, although results were somewhat mixed for the experience of abuse, PTSD symptoms were consistently found to be higher in secondary variants (Bennett and Kerig 2014; Kimonis et al. 2012b, 2013b, 2017b; Sharf et al. 2014; Tatar et al. 2012; Vaughn et al. 2009; Waller and Hicks 2019). Importantly, these findings were stable across studies that used PTSD symptoms as a clustering variable (Bennett and Kerig 2014; Kahn et al. 2013), as well as studies that clustered youth on CU traits or psychopathy and anxiety, and then tested concordant validation on PTSD symptoms (Kimonis et al. 2017b; Sharf et al. 2014; Tatar et al. 2012; Waller and Hicks 2019). In summary, despite differences in how the variants were identified, youth with the secondary variant reported higher levels of PTSD symptoms compared to their primary counterparts, and with only a couple exceptions, were found to have experienced higher rates of abuse. Results from studies that used CU traits and psychopathy were consistent in their findings on abuse and PTSD symptoms. These findings are congruent with the view that exposure to abuse and trauma, along with trauma symptoms, are a fundamental aspect of secondary variant etiology.

Processing of Emotional Information

Several studies examined differences in emotional processing among youth with primary and secondary CU traits ($k=6$) or psychopathy ($k=1$). The dot-probe task, which measures attention to emotional stimuli, was used in three studies to evaluate whether youth with primary and secondary variants showed more or less facilitation (i.e., attentional bias) toward facial displays of emotion. Results were mixed. Kimonis et al. (2008) found that youth scoring high on CU traits and parental abuse using a moderated regression model, consistent with secondary CU variants, showed hypervigilance to distress stimuli. In a second study with detained males, Kimonis et al. (2012a) found that youth with secondary psychopathy, clustered on psychopathy

⁴ Two studies used exposure to trauma/abuse as both a clustering variable and outcome variable.

⁵ Kimonis et al. (2012b) use the same sample and maltreatment measure as Kimonis et al. (2012a) and thus was removed from this summarization in this section of findings to avoid bias.

and anxiety, also showed enhanced sensitivity to distress pictures, while youth with primary psychopathy showed processing deficits. This difference was not found for positive stimuli. In contrast to the first two studies, Kahn et al. (2017) found that anxiety did not moderate the relationship between CU traits on sensitivity to distress in justice-involved males, although these authors cautioned that this result only appeared in post hoc analysis. Two of the studies noted (Kahn et al. 2017; Kimonis et al. 2008) relied on a variable-centered approach through a moderated regression, while the third study used a cluster analysis, making results difficult to compare between studies.

Three studies examined facial recognition accuracy between variants. Results of these studies were also mixed. In the same study as above, Kahn et al. (2017) found males high on CU traits and anxiety (i.e., secondary CU variant) to be less accurate in identifying facial expressions of fear and disgust. Again, the authors cautioned that these findings may have been an artifact of the large number of post hoc analyses performed. However, these results were not supported in the other two studies. Dadds et al. (2018) found youth with high CU traits and low levels of maltreatment (i.e., primary variants), as indicated through a moderated regression, to be associated with poor facial recognition. They did not find the same results for a moderated regression using anxiety instead of maltreatment. Similarly, Bennett and Kerig (2014) found justice-involved youth, with secondary CU traits being classified as having high levels of PTSD symptoms in addition to CU traits, were more accurate in identifying faces of disgust than were youth classified with primary CU traits. This study used a person-centered clustering approach. Interestingly, the authors found youth with secondary CU traits to have less acceptance of their own distressing emotional states, to be less able to clarify or distinguish their own emotions, and to be more prone to emotional numbing (e.g., avoiding awareness of distressing emotions; Bennett and Kerig 2014). These results contrast with the study's finding that youth with secondary CU traits were more accurate in identifying emotions in others and raise interesting questions about the precise nature of emotional processing differences between youth classified as primary versus secondary variants. It is possible, for example, that differences may be apparent in processing emotional information about others, but not necessarily about the self. Overall, findings for differences in emotional processing were mixed and seemed to vary based on methodology.

Biological Correlates

Six studies have examined biological correlates among primary and secondary CU variants. No studies on biological correlates used the full psychopathy measure. Of these six studies, three investigated salivary hormone levels; one

analyzed daily oxytocin patterns and two analyzed cortisol (with one also examining dehydroepiandrosterone [DHEA]—a neurosteroid coreleased with cortisol providing antiglucocorticoid effects). Other biological indicators included differences in startle potentiation ($k=2$), amygdala activation ($k=1$), and physiological activations ($k=2$). As some studies examined multiple indicators, results are organized by indicator rather than by study. Frangkaki et al. (2019) examined daily oxytocin patterns (a neuropeptide linked with social affiliation, emotion recognition, and empathy; Veening and Olivier 2013) among male adolescents living in residential youth facilities. Instead of a clustering method, this study tested the interaction of CU traits and forms of parental maltreatment (physical, sexual, and emotional abuse; and physical and emotional neglect) for predicting oxytocin levels. Youth with high CU traits and low levels of emotional neglect (primary variant) exhibited lower daily oxytocin salivary secretion, compared with youth with high CU traits and high levels of emotional neglect (secondary variant). The authors note that, interestingly, significant effects were only found for emotional neglect, suggesting that emotional neglect over other forms of parental maltreatment may be critical in the development of the oxytocin system and specifically secondary CU traits. Kimonis et al. (2017b) found youth with secondary CU traits have a unique high DHEA-to-cortisol ratio, consistent with hypothalamic–pituitary–adrenal (HPA) axis dysregulation. This study also found youth with primary CU traits have high DHEA levels relative to other groups, which they note is consistent with a stress resistant profile. Youth with primary and secondary CU did not differ in levels of cortisol in this study. Fanti and Kimonis (2017) found children with secondary CU traits have higher heart rates and lower morning cortisol levels. The authors' note that based on previous research, lower cortisol levels are associated with negative familial experiences, and chronic activation of the HPA axis may result in attenuated cortisol levels.

One study examined startle reflex of primary and secondary CU variants (Kimonis et al. 2017a). In this study, youth with secondary CU traits showed enhanced aversive startle potentiation relative to youth with primary CU traits and low CU traits controls. The authors propose that this aversive startle potentiation is indicative of amygdala dysfunction and emotional sensitivity (Kimonis et al. 2017a). It is important to note that in this study classification of youth with primary and secondary CU traits was based on their levels of maltreatment. This is significant as the author's note that exaggerated aversive startle potentiation is linked to high levels of anxiety as well as trauma symptoms. Thus, even though anxiety was not used to differentiate the variants, youth identified with primary and secondary CU traits differed on an objective measure of regulation and anxiety.

Using a threat conditioning task, Fanti et al. (2020) examined amygdala activity between justice-involved adolescents with primary versus secondary CU traits (clustered on CU traits, anxiety, and familial abuse) using functional MRI. Threat conditioning paradigms provide information regarding which associations with threats are learned (i.e., threat acquisition) and unlearned (i.e., threat extinction). Youth with primary CU traits showed lower right amygdala activity to neutral male faces relative to secondary CU variants and low CU groups; they also showed lower right amygdala activity during threat extinction compared with secondary CU variants and a group distinguished by a history of abuse. Hemispheric specialization of the right amygdala has been linked to quick unconscious detection of emotional stimuli (Costafreda et al. 2008). The authors suggest that among youth with primary CU traits diminished activity of the threat-processing circuit to neutral faces may reflect a baseline hypoactivation in these individuals, and during extinction could suggest impairments in modulation of attention.

In terms of physiological indicators of dysregulation, two studies examined heart rate across the variants. Fanti and Kimonis (2017) found children with secondary CU traits have higher heart rates. The authors argued that higher heart rate levels are related to heightened emotionality, consistent with the view of secondary variants (Beauchaine et al. 2000). In another study by the same research group, Fanti et al. (2018) used a multi-system (i.e., startle potentiation, heart rate, skin conductance, and medial prefrontal activity) physiological approach to investigate heterogeneity among children and young adults distinguished on CU traits, conduct problems, and anxiety. While groups did not differ on baseline heart rate or skin conductance activity, several differences were found for physiological reactivity, supporting the importance of examining responsiveness to emotional stimuli for an accurate understanding of individual differences. Across both groups, individuals with secondary traits showed greater startle reactivity and physiological arousal to violent, fearful, and anger stimuli compared to individuals with primary CU traits. In childhood, primary and secondary variants showed similar physiological reactivity to sad stimuli; and in adulthood, primary and secondary variants showed lower medial prefrontal cortex activity to violent stimuli relative to the anxious group. Activity in the medial prefrontal cortex has been linked to empathic concern (Seitz et al. 2006).

Behavioral Outcomes Associated with Primary Versus Secondary Variants

Eight studies examined differences in serious rule-breaking behavior, including substance use ($k=5$), aggression ($k=3$), and criminal behavior ($k=2$) associated with primary and secondary variants. Of these, results were inconsistent across

the three studies that examined differences in substance use in studies examining psychopathy variants. Two studies reported that incarcerated male adolescents with secondary psychopathy were significantly more likely than those with the primary psychopathy to use substances (Kimonis et al. 2012b; Veen et al. 2011). In particular, Kimonis et al. (2012b) found that adolescents with secondary psychopathy had significantly higher rates of substance use pre-incarceration and during incarceration, as well as significantly higher rates of substance use disorders currently or by history. More specific analyses indicated that alcohol abuse and/or dependence disorders were significantly more common in adolescents with the secondary variant than in those with the primary variant (Kimonis et al. 2012b). Veen et al. (2011) found that boys with secondary psychopathy were more likely to have used alcohol or cannabis in the month prior to their incarceration compared to boys with primary psychopathy. In contrast to these findings, an earlier study of incarcerated adolescents (primarily male) reported that youth with primary and secondary psychopathy did not differ significantly in terms of substance use over the past year (Vaughn et al. 2009). Two of these studies also found adolescents with psychopathy, whether primary or secondary, were more likely to meet diagnostic criteria for a substance use disorder than were incarcerated adolescents with low levels of CU traits (Kimonis et al. 2012b; Vaughn et al. 2009).

In studies examining CU traits and substance use, findings were more consistent. In a female sample that examined CU traits, Goulter et al. (2017) found that those classified with secondary CU traits scored higher on substance use than those classified in the anxious and control groups; however, they did not score higher than females with primary CU traits. Waller and Hicks (2019) did not find any difference in alcohol or marijuana use across the variants; however, they did find that impulse control mediated the association between secondary CU and alcohol use. Although some studies that examined primary and secondary psychopathy found differences across the variants, this was not a consistent finding with studies using CU variants. Taken together, substance use appears to be a significant concern in adolescents with CU traits and psychopathy, whether they exhibit primary or secondary traits, even during incarceration. However, differences across the variants are less clear and may differ based on whether psychopathy or CU traits are used.

Three studies examined different types of aggressive behavior associated with primary and secondary variants. Kimonis et al. (2011) examined a sample of incarcerated adolescent male offenders and found secondary psychopathy variants to engage in a significantly larger proportion of violent behavior during incarceration in the past two years compared to primary variants (92% vs. 69.4%). Further analyses indicated that the violent behavior of secondary variants was significantly more likely to be reactive in nature

(i.e., responding angrily to a perceived provocation; 82% of violent incidents) than that of primary variants (for whom only 54% of violent incidents were reactive in nature). In addition, secondary variants exhibited more variability in their violent behavior across a 2-year period, whereas incarcerated adolescents with primary psychopathy or low psychopathy had relatively stable rates of violent behavior over a two-year period. Similarly Fanti et al. (2013) found secondary CU variants to have higher levels of reactive aggression, but similar levels of proactive aggression compared to their primary counterparts. In contrast, a study of high-risk females found that those with primary and secondary CU traits were not differentiated on their self-reported levels of proactive and reactive relational aggression (Goulter et al. 2017).

Finally, Vaughn et al. (2009) examined differences in criminal behavior associated with primary and secondary psychopathy. In a sample of incarcerated youth, those with higher levels of psychopathy, whether primary or secondary, had significantly higher rates of violent offending, property offending, and overall delinquency than incarcerated youth with low levels of CU traits. Incarcerated youth with and without psychopathy (primary or secondary) did not differ significantly in terms of gang involvement, daily weapon carrying, or the age at which they began offending (Vaughn et al. 2009). However, individuals with secondary psychopathy had significantly higher self-reported violent and property offending and overall delinquency than did individuals with primary psychopathy. Collectively, these findings offer preliminary evidence that youth with psychopathy, and particularly those with secondary psychopathy, are significantly more likely to commit some criminal offenses. It should be noted that this study did not differentiate between relevant types of offenses (e.g., reactive vs. proactive offenses) making it difficult to understand these results alongside those in studies previously reviewed. Likewise, Robertson et al. (2018) found that anxiety moderated the effect of CU traits on violent offending, such that youth with high levels of CU traits and anxiety (i.e., secondary variants) had higher levels of self-reported offending. In summary, both variants appear more likely to engage in aggressive and criminal behavior and there are some preliminary findings that show secondary variants (both psychopathy and CU traits) may have higher rates of reactive aggression.

Studies Unable to Find Variants

Although the majority of papers identified two variants reflecting primary and secondary profiles using a variety of statistical analyses (e.g., clustering, LPA; $k=28$), three papers were unable to identify a secondary variant (Colins et al. 2018; Lee et al. 2010; Wareham et al. 2009). There were a few key methodological differences in these studies

compared to the others in the review. It should be noted that all three articles used the full psychopathy scale. In the study conducted by Wareham et al. (2009), the authors employed a different statistical approach (latent class factor analysis; distinct from LCA by relying on a factor analysis of psychopathy within each class), which was not used in any other study. Wareham et al. (2009) also included a broad measure of internalizing and externalizing problems, using the CASI (Meyers 1996). The CASI measures lifetime experiences of symptoms and the internalizing scale includes one item for each of: anxiety, depression, preoccupation with food or weight, shy, and low self-esteem. Unlike measures that rated symptoms on a three or four-point Likert scale on multiple items of anxiety, the CASI dichotomizes responses (i.e., “yes” or “no”). Based on these measure qualities, it is possible that this measure was not sensitive enough to capture the type of anxiety symptoms present in secondary psychopathy. The second study to not find primary and secondary variants used all three factors on the YPI in addition to anxiety (Colins et al. 2018). The authors found that in both moderate and high psychopathy clusters, anxiety levels were lower than in the high anxiety group. Likewise, Lee et al. (2010) found a high, moderate, and low cluster rather than a primary and secondary cluster. The high cluster included youth high on psychopathy and anxiety, the medium cluster represented youth with moderate levels of anxiety and psychopathy. The authors note that high and moderate group only differentiated on the interpersonal dimension of psychopathy and the difference between the high and moderate cluster on the affective component of psychopathy was less than a half standard deviation. Thus, it is possible that the moderate group represented primary variants, while the high group represented the secondary variant. This study highlights the possible problematic conflation of CU traits and psychopathy when identifying primary and secondary variants.

Discussion

The current study systematically reviewed the existing literature on characteristics that have been used to operationalize and differentiate primary and secondary variants among children and adolescents. We also reviewed the sample populations and methodologies that were used to define the variants. Finally, we reviewed evidence for theoretically relevant variables (i.e., abuse/trauma, emotional processing, and biological correlates), and behavioral outcomes (i.e., aggression/ rule-breaking behavior, substance use). There were multiple indicators of primary and secondary variants with CU traits or psychopathy, anxiety, and trauma symptoms being the most prominent. While the majority of earlier studies used justice-involved youth, the number of community and clinical samples have increased in the past

couple of years. Encouragingly, just over half of the studies were mixed gender. The majority of studies employed person-centered clustering techniques using anxiety to identify youth with primary and secondary variants; however, there was a variety of other methods used, including using mean splits (Rosan et al. 2015), tertile splits (Sharf et al. 2014), moderated regression analyses (e.g., Dadds et al. 2018; Kahn et al. 2017), and the inclusion of other variables to identify variants (e.g., trauma, aggression, behavior activation, behavior inhibition; e.g., Craig and Moretti 2019; Gill and Stickle 2016). Importantly, despite heterogeneity in model indicators and methods, the majority of studies reviewed identified two variants of youth—one characterized by under-arousal with low levels of anxiety (primary), and one characterized by over-arousal with high levels of anxiety (secondary). Even with varying rates of primary and secondary variants across sample characteristics, outcomes (e.g., trauma) were fairly consistent across populations (e.g., normative, clinical, and justice-involved), and age (e.g., young children through late adolescence). We aim to answer our research questions posed earlier including (1) whether there is support for the identification of primary and secondary variants, (2) whether there is enough heterogeneity in the samples to generalize results, (3) whether we have enough support for theoretical models, and (4) whether there is support for differential negative outcomes.

Is There Support for the Identification of Primary and Secondary Variants?

Results from the current review demonstrated that there are a variety of definitions for primary and secondary variants making comparisons across studies difficult. We outline several issues regarding the identification of primary and secondary variants in youth. First, there were several different psychopathy/CU traits constructs and measures used to distinguish variants. There were inconsistencies with regards to what constituted CU traits versus psychopathy. Specifically, several studies describing the construct of ‘psychopathy’ used a measure of CU traits (e.g., Docherty et al. 2016). It is important to note, that CU traits and psychopathy are distinct constructs, as a youth with CU traits may not exhibit some of the other characteristics of psychopathy (e.g., narcissism; Hare et al. 1991). A youth can score high on narcissism and antisocial behavior without necessarily scoring high on CU traits. As previously mentioned, there is ongoing debate around the conflation and predictive ability of CU traits and psychopathy (e.g., Andershed et al. 2018; Gillen et al. 2018), thus, further research on whether primary and secondary variants are related to CU traits, psychopathy, or both would help clarify this concern. Second, and relatedly, there were several different constructs and measures used to define the variants. Although CU traits and anxiety

were the most common variables used to distinguish primary versus secondary variants, there were a wide range of other measures that were also included in models (e.g., maltreatment, PTSD symptoms, affect regulation). Even within the same research group, different measures were used across multiple studies to define the variants (e.g., Kimonis et al. 2011, 2013b, 2017a, b). The range of indicators makes comparisons difficult across studies. It is possible a youth may change classification based on the indicators used in each study. Based on this review, researchers need to test competing models of primary and secondary variants using full psychopathy measures versus CU traits alone. Likewise, competing models need to test whether using theoretically relevant indicators, such as PTSD symptoms and trauma exposure, can identify the variants more consistently than the more common model that relies on anxiety.

The third issue is the differences in methodologies used to create CU variants. It is difficult to compare results from a cluster analysis with youth who meet a cutoff for having ‘high’ CU traits (e.g., Bennett and Kerig 2014), compared to the same methodology being used on the population as a whole (e.g., Kimonis et al. 2011). Differences in rates of primary and secondary variants highlighted the differences in methodology. The use of a clustering technique appeared to result in higher rates of both primary and secondary variants. Likewise, using a ‘high’ CU trait cutoff also resulted in higher rates of primary and secondary variants. The use of moderated regression (e.g., Kahn et al. 2017) compared to a cluster analysis may also result in different findings. It is also concerning that several studies employed LCA or LPA with three or fewer indicators as this methodology tends to result in a low, medium, and high cluster with fewer than four indicators.

Fourth, in addition to defining the variants, there is concern with regards to the choice of ‘validating’ measures. Given overlap in anxiety and PTSD symptoms; and thus, potential for artificially inflated associations; it is unsurprising that PTSD symptoms are elevated in secondary variants as defined by heightened levels of anxiety. Similarly, some studies used measures of dysregulation (Craig and Moretti 2019) or behavior inhibition and activation (Gill and Stickle 2016) to define CU variants, and also examined levels of psychopathology related to dysregulation as outcomes. Thus, it is expected that these studies found higher rates of psychopathology among secondary youth also characterized by dysregulation and over-activation. Given these overlaps, and once we have an established way of constructing the variants, it is possible that validating measures may not be necessary once groups are established.

Finally, there was also concern with regards to the three studies that used Factor 1 (i.e., affective deficits) and 2 (i.e., antisocial behavior) from the psychopathy construct as ‘primary’ and ‘secondary’ variants, respectively (Bjørnebekk

and Gjesme 2009; Hicks et al. 2012; Vaillancourt and Brittain 2019). While some adult literature has argued that these factors are representative of the variants (Poythress and Skeem 2005), this theory has not been well established in the youth literature. Further, by definition, primary and secondary variants must both be characterized by features of Factor 1 (i.e., the affective dimension). Thus, we were unable to adequately compare studies that labeled youth scoring highly on Factor 1 as “primary” and youth scoring highly on Factor 2 as “secondary”. Taken together, common methodology, terms, and constructs need to be established across the literature to allow for better comparisons across studies.

Is There Sufficient Heterogeneity in the Samples to Generalize Results?

To be confident in the generalizability of the variants, the model should hold across heterogeneous samples; however, the relative homogeneity of the samples examining CU and psychopathy variants is a limitation. Although there is an increasing number of studies that examine non-justice-involved youth, a large proportion of the studies (39%) in the current review relied on data from boys involved in the justice system. This may be due to the higher rate of CU traits in this population; however, the limited number of studies drawing from normative samples makes conclusions difficult to generalize. Differences in rates were noted across populations, with justice-involved samples finding higher rates of primary and secondary variants compared to normative samples. It should be noted that clinical samples had similar rates of the variants compared to justice-involved samples.

One potential strength in the heterogeneity of results was the diverse ethnicity of the samples across the studies. Although a number of the studies had significantly more Caucasian participants than other ethnicities, some studies with justice-involved youth had higher rates of Black and Hispanic populations (e.g., Kimonis et al. 2008; Lee et al. 2010). This is somewhat unsurprising given the higher rates of ethnic minorities within the justice system (Piquero 2008). It is interesting to note that the clinical and community samples were drawn from multiple countries and continents and included samples from Asia (Huang et al. 2020), Mediterranean (Fanti et al. 2018), Northern Europe (Fragkaki et al. 2019), Australia (Dadds et al. 2018), and North America (Craig and Moretti 2019). However, most participants in these studies were Caucasian. This makes generalizing results from community and clinical samples more difficult as there may be cultural differences in the development of expression of primary and secondary variants. One consideration, for example, is that in some cultures it is not acceptable to display reactivity or dysregulation (Lim 2016), which may result in a smaller number of youth

with secondary variants. Thus, it would be important for researchers to over-sample ethnic minorities in future community and clinical studies to examine potential differences across the variants.

Another area of consideration in the samples was that about half of the studies used a male sample. The majority of justice samples only included male participants, which is consistent with literature that has demonstrated a smaller proportion of females in the justice system (Pusch and Holtfreter 2017). However, this makes their results difficult to generalize to females. Thus, it is particularly important to examine gender in community and clinical populations as these studies may provide researchers with a more balanced gender sample. There was little agreement across studies regarding gender differences between primary and secondary variants, with some studies finding more female secondary variants, or male primary variants, while others did not find a gender difference (e.g., Docherty et al. 2016; Fanti et al. 2013). Gender differences are further complicated by potentially gendered diagnosis related to CU traits or psychopathy. In the adult literature, it has been argued that psychopathy and Borderline Personality Disorder (BPD) are gendered, with some studies finding women with BPD features to present with features similar to secondary variants (Sprague et al. 2012). This is an area of research that requires additional work. Where possible, researchers need to examine gender and sex differences across the variants to continue to build this area of research.

Finally, no study specifically examined developmental differences in ages of participants. It is unclear based on the original developmental theory (Porter 1996) when secondary variants would emerge. This is further complicated by the use of CU traits versus the full measure of psychopathy, as Porter (1996) proposed that CU traits may develop during childhood, while socially deviant behavior may emerge later in adolescence. It is possible that it takes many years of repeated abuse and dysregulation for a child to emotionally detach and develop secondary psychopathy, whereas secondary CU traits may be found earlier in development. However, given this theory has not yet been fully tested, it is not possible to make judgments related to developmental timing differences of primary and secondary variants.

Is There Support for the Theoretical Model of Multiple Etiologies?

One of the main objectives of this review was to assess evidence for the theory of primary and secondary variants, specifically the role of abuse/trauma and emotional processing deficits in distinguishing youth with primary and secondary CU traits or psychopathy. Interestingly, although the review found that, for the most part, youth with secondary variants reported experiencing more abuse/trauma

than their primary counterparts, this was not the case in every study (Humayun et al. 2014; Kimonis et al. 2013b, 2017b). However, consistent with the proposed theory that secondary variants experience a heightened trauma reaction (Porter 1996); the review found that trauma symptoms such as non-acceptance of emotions (Bennett and Kerig 2014), arousal and avoidance (Sharf et al. 2014), and other PTSD symptoms (Kimonis et al. 2017b), were higher in those with the secondary variant compared to both primary variants and low CU/psychopathy controls. Children who have experienced abuse or maltreatment by their caregiver can experience a number of different trauma reactions, including hypervigilance and dysregulation (Cicchetti 2016), and/or emotional numbing (Kerig et al. 2012). Trauma symptoms are believed to be at the core of the development of secondary variants as youth attempt to cope with their trauma experiences through the numbing of emotions (Bennett and Kerig 2014). Based on trauma literature, coping through emotional numbing and inhibition of empathy for others is reinforced because this strategy effectively lowers distress in the short term, and is especially adaptive in contexts where children or adolescents cannot escape trauma (Lansford et al. 2006). Although this strategy may be effective in the short term, research has shown that suppression or numbing of emotion leads to a paradoxical increase in unwanted emotional distress, including physiological indicators of distress (Hofmann et al. 2009). This cycle of suppression and dysregulation could impact youth's ability to process emotions effectively, leading to the development of CU traits to cope with overwhelming emotions. In support of this cycle, Craig and Moretti (2019) were able to identify secondary variants on their levels of affect dysregulation and suppression in addition to maltreatment, anxiety, and CU traits. Other studies in the present review also found associations between secondary CU traits and emotional numbing (Bennett and Kerig 2014), and affect intensity (Gill and Stickle 2016). However, it is critical to note that no studies reviewed provided an adequate test of this developmental model longitudinally. Thus, prospective, longitudinal research examining developmental pathways to CU variants is required to test this theory.

One finding from this study was the conflation of abuse/maltreatment and trauma. There is some evidence that the perpetrator may be important to the trauma response. For example, betrayal trauma has been linked to CU traits through emotional numbing (Kerig et al. 2012). It may be that maltreatment at the hands of caregivers or other important people in a youth's life is more salient in the development of CU traits than other forms of trauma. However, this hypothesis has yet to be tested. Further, caution should also be used when describing maltreatment as an outcome as some studies examined maltreatment or trauma as an indicator of the variants, while others used it as an outcome.

In terms of emotional processing, there was evidence that those with the secondary variant are more accurate in identifying faces of fear or disgust (Bennett and Kerig 2014), and are more engaged with distressing stimuli (Dadds et al. 2018; Kimonis et al. 2008, 2012a); however, these findings are not consistent across studies. In addition, studies found secondary variants to also be less accepting of their emotions (Bennett and Kerig 2014), and to have higher levels of affect suppression (Craig and Moretti 2019). The results lend support to Porter's (1996) theory that secondary CU traits may arise in youth who have greater sensitivity to emotions, but have difficulties in processing emotions, negatively impacting their moral socialization. Porter's (1996) developmental model suggests when youth effectively inhibit their capacity to feel, they experience a deactivation or dissociation from processes involved with emotional development and moral reasoning, and as a result do not develop age appropriate skills in these domains. However, their attempt at deactivation (e.g., numbing or suppression of emotion) paradoxically leads to an increase in feelings of dysregulation, or anxiety. This paradoxical effect may help explain some of the differences in emotional processing outcomes in the current review. Due to these overwhelming feelings of dysregulation, youth with the secondary variant may experience an interruption in their moral socialization as they become unable to effectively process other's negative emotions following a transgression (Kimonis et al. 2008). This disruption may also lead to an increase in delinquent and self-destructive behavior.

Divergent processing of emotions by youth with primary versus secondary variants may be underpinned by distinct biological correlates. The current review found evidence from biological indicators that support the hyper- and hypoarousal theory including in the endocrine (Fragkaki et al. 2019; Kimonis et al. 2017b), psychophysiological (Fanti and Kimonis 2017; Fanti et al. 2018; Kimonis et al. 2017a), and neurological (Fanti et al. 2020) domains. Across six studies, using different indicators, youth with the secondary variant displayed profiles consistent with hyperarousal and dysregulation of stress response systems linked to experiences of trauma, whereas youth with the primary variant had a biological profile more closely in line with findings examining CU traits and psychopathy more broadly and reflecting stress resistance (Blair et al. 2018). The majority of findings were consistent with disruption to limbic structures, specifically the amygdala and associated systems (i.e., the HPA axis). Impaired amygdala functioning hinders reinforcement learning rendering individuals scoring high on CU traits or psychopathy incapable of associating their antisocial actions to others distressed emotional states, which may explain findings related to primary variants (Glenn and Raine 2008). Conversely, experiences of trauma dysregulate HPA axis activity (via overstimulation

of the amygdala on the paraventricular nucleus of the hypothalamus) and repeated cycles of allostasis creates strain on hormones and other systems, known as allostatic load (McEwen 2007). Allostatic load increases vulnerability to symptoms commonly observed among secondary variants (e.g., anxiety, depression; McEwen 2007). While research investigating biological correlates of variants is limited, these findings support the possibility of distinct biomarkers among youth with primary versus secondary variants. Future research should continue to investigate potential biomarkers of variants, with a focus on reactivity indicators and multi-system investigations (Fanti et al. 2018).

One notable missing area of research in the review was the lack of studies examining moral socialization. Although we note in the introduction the central role of moral socialization in the theory of CU traits (Kimonis et al. 2008), we were unable to locate studies that specifically address this construct. There is a significant need for this area to be studied to validate the proposed theory of primary and secondary variants.

Is There Evidence of Differential Negative Outcomes for Primary and Secondary Variants?

Youth with CU traits and psychopathy, regardless of variant type, were found to be more likely than youth with low CU traits or psychopathy with conduct problems to engage in serious rule-breaking behavior, including committing criminal offenses (e.g., Kimonis et al. 2012b; Vaughn et al. 2009). The increased likelihood of youth with CU traits engaging in these concerning behaviors is consistent with the disruption in moral socialization. That is, youth with both primary and secondary variants may not be deterred from engaging in antisocial behavior because committing transgressions results in relatively lower levels of distress than it would in youth without CU traits (Kimonis et al. 2008). However, youth with primary and secondary variants also differ in terms of their rule-breaking behavior in ways that are consistent with the characteristics and hypothesized etiologies of the two variants. In particular, youth with secondary variants are more likely than youth with primary variants to exhibit reactive aggression (Fanti et al. 2013; Kimonis et al. 2011), a finding that is in keeping with the overall characterization of the secondary variant as sensitive and hyperaroused despite their perceived lack of emotion (Bagley et al. 2009; Frick and Morris 2004).

In addition, although the results are inconsistent, there is some evidence that overall CU traits and psychopathy are associated with an increased likelihood of substance abuse compared to youth with low CU traits or psychopathy (Goulter et al. 2017; Kimonis et al. 2012b; Veen et al. 2011). While variants may engage in similar levels of substance use, substance use may serve a different purpose for

youth with primary and secondary variants. Youth with the primary variant may engage in substance use as a stimulant due to their fearless temperament and their insensitivity to punishment, while those with the secondary variant may use substances to reduce central nervous system hyperactivity and hyperarousal (Kimonis et al. 2012b). Likewise, secondary variants may also engage in substance use due to their poor impulse control, a potential consequence of dysregulation. Indeed, Waller and Hicks (2019) found impulse control mediated the relationship between secondary variants and alcohol use. Should this finding receive further support, substance use may represent a further attempt at numbing and emotional suppression among those with the secondary variant. Evidence from adult samples has generally demonstrated that secondary psychopathy is associated with more substance abuse pathology compared to adults with primary psychopathy (Skeem et al. 2002; Swogger and Kosson 2007; Vassileva et al. 2005); however, some inconsistent findings are evident in our review of adolescent samples (Goulter et al. 2017; Kimonis et al. 2012b; Vaughn et al. 2009; Veen et al. 2011; Waller and Hicks 2019). It is possible that differences in the adult literature versus the current findings in youth literature may be explained by the relative increase in substance use in adolescence (Chen and Jacobson 2012). Further research is therefore necessary to determine whether adolescents with the secondary variant are indeed more likely to use substances than those with the primary variant. It should also be noted that the majority of the studies reviewed did not evaluate longitudinal outcomes for youth with primary and secondary variants who engaged in substance use.

What are the Clinical Implications of Primary and Secondary Variants?

Understanding potential differences in the treatment of primary and secondary variants is critical as the presence of CU traits has been noted as a significant moderator of treatment designating a group of youth who are generally treatment resistant (Frick et al. 2014; Hawes et al. 2014). Some studies have examined changes in CU traits in children across treatment with medium sized effects (Cohen's $d=0.44$) (Kolko and Pardini 2010); however, others have found that similar treatment for adolescents have not been as successful in decreasing levels of CU traits (e.g., multi-systemic therapy; Butler et al. 2011; Manders et al. 2013). One possible reason for non-response could be that youth with primary and secondary CU traits may need to be treated with different approaches. There have been attempts to develop interventions that target emotional processing deficits that stem from hypoarousal, a feature of primary CU traits. Interventions that address the child's insensitivity to distress cues (Kimonis et al. 2018), or the empathy skills (Dadds et al. 2012),

have been shown to be moderately effective. However, it is unclear whether addressing a child or youth's empathy skills would aid with the hyperarousal and sensitivity found in youth designated as a secondary variant.

With the trauma history and hyperarousal in youth with the secondary variant it is possible that they may respond well to treatments that target the rebuilding of parent–child relationship. Indeed, a number of treatment studies have demonstrated that interventions that promote parental warmth and involvement reduce symptoms of psychopathy and CU traits in younger youth (e.g., McDonald et al. 2011; Pasalich et al. 2016). The current review found that harsh parenting may be implicated in youth with both primary and secondary variants (Humayun et al. 2014; Meehan et al. 2017), thus addressing parental harshness and warmth may therefore be effective for both variants. Taken together, children and youth with primary CU traits may benefit from interventions that target emotion recognition or empathy skills through the parent–child relationship (Hawes et al. 2014). Likewise, as youth with secondary CU traits and psychopathy show greater impairments in coping skills (i.e., emotional regulation) and interpersonal relationships (e.g., relational aggression), programs aimed at addressing dysregulation processes through the parent–child relationship may be more effective. Given the current research, researchers need to take into consideration the two profiles of adolescents with CU traits/psychopathy and treat the underlying causes of youth with primary and secondary variants in different ways. Although there is growing evidence for the importance of distinguishing youth with primary versus secondary CU traits, there is limited information on different intervention effects for the variants. Thus, future research may need to evaluate the potential moderating effect of anxiety in treatment for youth with CU traits.

Limitations of Current Research

The current study provides the first review of evidence for primary and secondary variants in children and adolescents. Although the systematic nature and comprehensive examination of the studies were a strength of the review, there are several limitations to note. First, the original search terms were unable to locate six important studies. This was partially due to the use of the term CU traits in the search, as some studies referred to CU features (Craig and Moretti 2019), and interpersonal callousness (Meehan et al. 2017). This limitation was rectified by including an ongoing Google scholar search using the phrase “CU variants”; however, it is possible that other relevant studies were missed. Second, the age criteria cutoff. A small number of studies examined youth that were late adolescents into early adulthood; however, with a mean age cutoff of 18, these studies were not included in the current review. This was to avoid including

the adult conceptualization of primary and secondary variants in the current study. Finally, the authors chose to not summarize the three studies that examined primary and secondary variants using Factor 1 and 2 of psychopathy. In all other studies, both primary and secondary variants scored highly on CU traits or the affective component of psychopathy, consistent with Karpman's (1941) original theory and Porter's (1996) developmental theory. It should be noted that in all three studies, secondary traits (impulse antisocial dimension) were related to more environmental risks (Hicks et al. 2012) and dysregulation (Bjornebekk and Gjessme 2009; Vaillancourt and Brittain 2019).

Where Do We Go from Here?

Despite differences in methodologies, the review identified multiple lines of evidence that support the existence of at least two different presentations of CU traits and psychopathy. However, more research is needed, particularly in three key areas. First, researchers need to be consistent in the methodology and constructs used for primary and secondary variants in order to compare results across studies. From the current study, it appears it is the reaction to trauma, or the trauma symptoms (e.g., anxiety, emotional numbing, dysregulation), in addition to CU traits, may be the most consistent definition of secondary variants; however, replication across developmental levels, gender, and ethnicities is required to establish these findings. This is an important distinction to be considered as anxiety in general may be too broad of a construct, and multiple studies have found CU traits to be generally related to low-warmth parenting and abuse (e.g., Kimonis et al. 2013a; Pasalich et al. 2015). Future research may want to examine competing models of primary and secondary variants in which exposure to maltreatment, anxiety alone, and trauma symptoms are compared as indicators. Second, given that Porter (1996) theorized a developmental progression of symptoms in youth with secondary CU traits/psychopathy, it is possible that there will be developmental differences from childhood to late adolescence in the rate and presentation of secondary CU traits. It could be that it takes several years of maltreatment exposure for secondary CU traits to emerge, perhaps explaining some divergence in the evidence of validating variables and behavioral outcomes to date. Thus, prospective longitudinal research is needed to better understand the developmental unfolding and process for those with secondary CU traits. Finally, there is no current research on the effect of primary and secondary variants on treatment outcomes. It is possible that those with primary and secondary CU traits differ in their response to treatment, making this a critical research gap that needs to be filled.

Author Contributions All authors contributed to the study conception and design. Review preparation and literature search was performed by SC. Article review and data analysis was performed by SC and NG. The first draft of the manuscript was written by SC with contributions by NG, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Compliance with Ethical Standards

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

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