



Contributions of socioeconomic status and cognition to emotion processes and internalizing psychopathology in childhood and adolescence: A systematic review

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ABSTRACT

This systematic review evaluated evidence from 25 manuscripts regarding three possible relationships of socioeconomic disadvantage (SESD) and cognition to emotion knowledge (EK), emotion regulation (ER), and internalizing psychopathology (IP) across development; a) independent contributions of disadvantage and cognition; b) cognition mediates relations of disadvantage; or c) cognition moderates' relations of disadvantage. Results support associations between SESD and cognition to emotion that differ by cognitive domain and developmental epoch. For EK, in early and middle childhood language and executive functions contribute to EK independent of SESD, and early childhood executive functions may interact with socioeconomic status (SES) to predict prospective EK. Regarding ER, language contributes to ER independent of SES across development and may mediate associations between SES and ER in adolescence. Regarding IP, SES, language, executive function, and general ability have independent contributions to IP across development; in adolescence executive function may mediate or moderate associations between SES and IP. Findings highlight the need for nuanced and developmentally sensitive research on the contributions of SESD and domains of cognition to emotion.

1. Introduction

In the United States, 44% of children are socioeconomically disadvantaged (i.e., living with families with incomes at or near the federal poverty line as defined by the Department of Health and Human Services) (Koball and Jiang, 2018). Socioeconomic disadvantage (SESD) is associated with reduced neurocognitive abilities, particularly in language and executive function (EF) (Merz, Wiltshire et al., 2019). These findings are important beyond cognitive development, with potentially compounding effects across developmental domains, given evidence that cognition and emotion are dynamic developmental processes, whereby the maturation of one process serves as a foundation for, and promotes cascades of the growth and function of, higher level skills (M. A. Bell et al., 2019a; Davidson et al., 2014; Wolfe and Bell, 2004). Furthermore, previous literature implicates altered cognitive processes as risk factors for both childhood and adult-onset psychopathology (Salmon et al., 2016; Zelazo, 2020).

Given the well-documented contributions of cognition to emotion and psychopathology (M. A. Bell and Wolfe, 2004; Zelazo, 2020), early emerging cognitive deficits in the context of socioeconomic disadvantage may confer risk for disruptions in emotion processes and psychopathology. Following, within-individual differences in cognitive functioning, such as those that correspond to normative developmental maturation of executive function and language, and between-individual differences in cognitive functioning, such as those attributed to socioeconomic disadvantage, contribute, and may interact to contribute to the development of emotion knowledge, emotion regulation and risk for internalizing psychopathology (M. A. Bell et al., 2019; M. A. Bell and Wolfe, 2004; Bennett et al., 2005; Cutting and Dunn, 1999). As such, the purpose of the current systematic review is to examine evidence for mediation, moderation, and independent associations of cognition to altered emotion processes specifically within the context of socioeconomic disadvantage.

For cognition we focus on language, executive function, and general

Abbreviations: SESD, Socioeconomic disadvantage; INR, Income to needs ratios; EF, Executive function; IC, Inhibitory control; IP, Internalizing psychopathology; SR, Self-regulation; GA, General ability; IQ, Intellectual quotient; EK, Emotion knowledge.

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intellectual ability. For emotion, we focus on emotion knowledge, emotion regulation, and internalizing psychopathology. We focus on internalizing and not also externalizing psychopathology because comparatively less literature has outlined the contributions of disrupted cognitive abilities to internalizing disorders, and because of the conceptual link between emotion processes and internalizing disorders. This paper begins by summarizing the literature on the contributions of SESD to altered cognition, emotion, and internalizing psychopathology, and summarizes literature on the contributions of cognition to emotion and internalizing psychopathology across development to set the stage for examining the interrelations of these two factors to the outcomes of focus in this review. Following this summary, we present a systematic review of 25 manuscripts that examine evidence for mediation, moderation, and independent associations of cognitive functioning to emotion processes in the context of socioeconomic disadvantage during different developmental epochs (early childhood, middle childhood, and adolescence).

1.1. Childhood SESD and cognitive functioning

There is robust evidence that of all the cognitive domains, language is most consistently associated with SESD (Johnson et al., 2016; Merz, Wiltshire et al., 2019; Pace et al., 2017; Perkins et al., 2013a). Throughout development, beginning as early as six months of age, as much as 32% of the variance in language abilities, including expressive language (i.e., communication of thoughts and feelings through words, gestures, signs, and/or symbols) and receptive language (i.e., comprehension of information provided in a variety of ways such as with words, movements, and gestures) can be explained by socioeconomic status (SES) (Merz, Wiltshire et al., 2019; Pace et al., 2017; Perkins et al., 2013a); this corresponds to a medium-to-large effect sized difference in the language abilities between SESD youth and their non-disadvantaged peers (Merz, Wiltshire et al., 2019).

Regarding executive function (EF), a set of cognitive skills that support top-down coordination and goal-directed daily actions, there is evidence that SESD is associated with small-to-medium effect size differences in EF skills throughout development beginning in infancy and continuing through adulthood (Lawson et al., 2018; Merz, Wiltshire et al., 2019). A recent meta-analysis reported that between the ages of two and 18, SESD is most strongly associated with a composite EF, followed in magnitude by working memory (WM), attentional control (AC)/cognitive flexibility (CF), and inhibitory control (IC), respectively (Lawson et al., 2018). Importantly, authors of the aforementioned meta-analyses could not conclude whether certain developmental periods were more sensitive to the effects of SES on EF (Lawson et al., 2018). Emerging theories, however, hypothesize that chronic SESD is a more salient risk factor for poor EF than shorter SESD exposure (Evans et al., 2021) and suggest that because the prefrontal cortex (PFC), which contributes to EF, undergoes rapid developmental reorganization during the first six months of life and during adolescence, these two developmental epochs may be sensitive periods for the influence of SESD on EF (Evans et al., 2021; A. Thompson and Steinbeis, 2020).

It is well documented that language and EF are the neurocognitive domains most impacted by SESD (Lawson et al., 2018; Merz, Maskus et al., 2019; Palacios-Barríos and Hanson, 2019; Perkins et al., 2013a), but there is also evidence SESD is associated with lower general intellectual ability (i.e., GA, IQ) (Bradley and Corwyn, 2002; Najman et al., 2009; National Institute of Child Health and Human Development Early Child Care Research Network, 2005). It is important to note that GA (i.e., IQ) tests measure various broad cognitive abilities and that there are inconsistencies across measures and manuscripts in the domains assessed, and resultant the construct of intelligence (i.e., GA) implied. Moreover, empirical evidence indicates that assessments of GA (i.e., IQ) have poorer predictive and construct validity for historically marginalized communities, including those who experience SESD (Edwards, 2007). Accordingly, associations between SESD and GA may reflect

some degree of systematic measurement biases against marginalized groups rather than true differences in the cognitive abilities reflected in assessments of GA (Edwards, 2007).

With these important caveats in mind, there is evidence that as early as 12 months of age, SESD is associated with lower GA scores (Bradley and Corwyn, 2002; Korenman et al., 1995). Although equivocal, the nascent literature points to SESD experienced in the first six years of life, and chronic relative to transient SESD, as especially predictive of lower GA scores (Korenman et al., 1995; Najman et al., 2009). Moreover, there is some indication that certain facets of SES may be more important to GA but that this pattern may be moderated by age, such that during early childhood parental education is particularly predictive of child GA, whereas family income is more predictive of IQ during adolescence (Bradley and Corwyn, 2002).

In sum, there is robust evidence that SESD is associated with reduced cognitive abilities in the domains of language and EF and on assessments of GA beginning in infancy and throughout development (Bradley and Corwyn, 2002; Brandes-Aitken et al., 2019; Korenman et al., 1995; Lawson et al., 2018; Merz, Maskus et al., 2019; Pace et al., 2017; Perkins et al., 2013a). Across all three domains, these small-to-medium sized differences are generally more pronounced in youth who experience early-life exposure to SESD and who experience chronic SESD (Bradley and Corwyn, 2002; Najman et al., 2009; National Institute of Child Health and Human Development Early Child Care Research Network, 2005). Importantly, some evidence indicates that certain facets of cognition may be differentially influenced by exposure to certain metrics of SES than others and that the nature of these relationships may be moderated by developmental epoch.

1.2. Childhood SESD and emotion knowledge, emotion regulation, and internalizing disorders

Comparatively less literature has examined associations between SESD and emotion processes in early and middle childhood, and results in adolescents are equivocal (Johnson et al., 2016). The nascent literature indicates that SESD is associated with poorer emotion knowledge (EK) and emotion regulation (ER) in early and middle childhood (Cutting and Dunn, 1999; Ellis et al., 2014; Garner and Spears, 2000; Merz, Maskus et al., 2019; Schultz et al., 2001), and perhaps in adolescence (Herd et al., 2020; Johnson et al., 2016; Lambert et al., 2017), and greater symptoms and diagnoses of internalizing disorders across development (Peeverill et al., 2021).

Emotion knowledge (EK) reflects an understanding of the causes, consequences, and display rules of an emotion (Izard et al., 2011). There is strong evidence that as early as three years old and through middle childhood (i.e., between the ages of six and 11), SESD youth have poorer EK than non-disadvantaged youth (Cutting and Dunn, 1999; Fine et al., 2003; Garner and Spears, 2000; Merz et al., 2015; Schultz et al., 2001). This is salient given evidence that greater emotion knowledge is associated with less psychopathology and more adaptive and academic success, both concurrently and prospectively (Finlon et al., 2015).

Emotion regulation (ER) is a broad construct that refers to strategies which influence how intensely emotions are experienced, when they are experienced, and how they are expressed. The earliest examinations of the association between SES and ER reported that SESD was associated with poorer ER in preschool (Ellis et al., 2014; Gross, 1998). Studies in middle childhood report similar negative associations between SES and ER (Raver et al., 2015, 2016). In adolescence, some investigations find a negative association between SES and ER, and others find no relationship (Herd et al., 2020; Lambert et al., 2017). These differences, however, may reflect the varied aspects and related operationalizations of ER and high co-occurrence of SESD with other adverse experiences that influence ER (Lambert et al., 2017; Sheridan and McLaughlin, 2014). A discussion differentiating the associations of SESD and other adverse experiences with emotion is outside of this review's scope, but it is worth noting that there is a great deal of overlap between SESD and exposure

to other forms of childhood adversity, like maltreatment and chronic stress, and that these forms of childhood adversities are associated with EK and ER (Johnson et al., 2016; Palacios-Barrios and Hanson, 2019; Sheridan and McLaughlin, 2014).

Regarding internalizing disorders (i.e., disorders characterized predominantly by anxiety, depressive, and somatic symptoms), a recent meta-analysis reported that between the ages of three and 19, SESD was associated with greater internalizing symptomatology (e.g., withdrawal, guilt, depressed mood) and greater diagnosis of internalizing disorders (e.g., Major Depressive Disorder, Generalized Anxiety Disorder) (Peeverill et al., 2021). Of note, although SESD is associated with greater externalizing psychopathology (e.g., Oppositional Defiant Disorder, Attention Deficit Hyperactivity Disorder) (Peeverill et al., 2021), comparatively less literature has outlined the contributions of poorer cognitive abilities to internalizing disorders, and as such this review will highlight contributions to internalizing disorders.

In sum, the literature indicates that SESD is associated with poorer EK and ER, and greater internalizing psychopathology, and that a host of factors may mediate these associations.

1.3. Cognitive processes and their relationship to emotion outcomes

Cognitive processes, such as those influenced by SESD, have a dynamic interplay both developmentally and neurally with emotion processes (Bell et al., 2019; Davidson et al., 2014; Wolfe and Bell, 2004). Importantly, the literature supports that cognitive and emotion process influence each other bi-directionally; just as cognition affects emotion, emotion also affects cognition (Barnett and Ratner, 1997; M. A. Bell and Wolfe, 2004). However, studies largely support that EF and language development precede, and are precursors to, EK and ER maturation; accordingly, this review focuses on the contributions of cognition to emotion (Barnett and Ratner, 1997).

1.3.1. Contributions of language to EK, ER, and internalizing psychopathology

Although outside of the scope of this work to review exhaustively, different theories about emotion highlight the role of language to a greater extent than others (Lindquist, Satpute et al., 2015). This review aligns with constructionist accounts of emotion, which posit that language is a mechanism for acquiring and using emotion concept knowledge to make meaning of valenced affective states across the life span (Barrett et al., 2015; Lindquist, 2017; Shablack and Lindquist, 2019). Constructionist accounts of emotion highlight the sequential development of language and emotion processes (e.g., EK, ER) as indicators that language is a mechanism in emotion perception and indicate that language allows for the acquisition and application of conceptual emotion knowledge (Lindquist, Satpute et al., 2015; Shablack and Lindquist, 2019).

EK undergoes a process of protracted development between infancy and adolescence. By two years old, concurrent with the emergence of more mature expressive language, there is evidence that toddlers begin to understand emotional expressions as indicated by the mapping of labels to simple emotion faces (Bell et al., 2019; Denham, 2019). By the preschool period, most youth begin to infer basic emotions from expressions and situations (Bell et al., 2019; Denham, 2019). Early on, EK of more positively valenced emotions is more developed, but by age six, youth identify and label prototypical facial expressions of happiness, sadness, and anger with adult-like accuracy (Izard et al., 2011). By middle childhood, there is marked improvement in the understanding that different events elicit different emotions in different people, and by adolescence, youth understand that there are multiple contributors to emotions and emotion display rules (Denham, 2019).

There is evidence that better language and greater access to semantic knowledge, specifically, supports emotion perception and understanding (Gendron et al., 2012; Lindquist et al., 2012; Lindquist, Satpute et al., 2015). Empirical evidence in both early and middle childhood

demonstrates positive associations between language and EK (Beck et al., 2012; Bosacki and Moore, 2004; J. S. Cohen and Mendez, 2009; Cole et al., 2010; De Rosnay et al., 2004; Grazzani et al., 2018; Nook et al., 2017; Pons et al., 2003; Reilly and Downer, 2019). Conversely, there is evidence that youth with language impairments perform worse on both verbal and non-verbal assessments of EK (Rieffe and Wiefferink, 2017). There is also some indication that receptive language is more predictive of EK in middle childhood than expressive language (Beck et al., 2012) but studies examining the relative contributions of domains of language to EK across development are limited, likely a result of relatively few examinations of EK in adolescence and beyond (Castro et al., 2016). Despite evidence that language and EK are positively associated in early and middle childhood, there is a dearth of empirical literature examining mechanisms underlying this relationship or examining this relationship beyond middle childhood. It has been hypothesized that youth with better expressive language abilities may engage in more frequent emotional conversations with peers and that these conversations facilitate a greater understanding of emotional concept knowledge, including an understanding of the antecedents, states, and display rules of an emotion (Ogren and Johnson, 2020). Consistent with constructionist accounts of emotion, this hypothesis implies that language supports EK because it enables the acquisition and sharing of relevant knowledge about different emotion categories in both the self and other (Lindquist, MacCormack et al., 2015).

Like EK, ER undergoes protracted development maturing from predominantly caregiver-supported ER in infancy to co-regulation of emotion in early childhood toward increasing self-reliance for ER between middle childhood and adolescence (Bell and Calkins, 2000; Thompson, 1991). Accordingly, expectations about the deployment of ER strategies move from encompassing a more limited set of more reflexive ER strategies (e.g., emotion expression, self-soothing) to a broader set of more volitional, cognitively and behaviorally complex forms of ER, like cognitive reappraisal and situation modification (i.e., changing a situation in order to alter its emotional impact) (R. A. Thompson, 1991). Burgeoning language and cognitive development support movement toward more autonomous, complex forms of ER (R. A. Thompson, 1991). For language specifically, there is evidence that expressive language maturation supports more socially appropriate means for emotion expression (i.e., reduces emotion dysregulation), enables the transition from caregiver-supported ER to more autonomous forms of ER, and facilitates the use of more linguistically complex forms of ER like cognitive reappraisal (Brinton and Fujiki, 2011; Eisenberg et al., 2005; R. A. Thompson, 1991). Around age 2, corresponding to an increase in expressive language, children begin to use language to express their internal emotional states and communicate their desires and needs with caregivers (Cole et al., 2010). By toddlerhood, enhanced language abilities predict more socially appropriate emotion expression and ER as indicated by increased use of autonomous adaptive ER (e.g., focused distraction) and decreased emotion expression (e.g., anger expression) (Bendezú et al., 2018; Cole et al., 2010). This pattern of results continues in middle childhood and adolescence, with evidence that youth with greater language abilities are more likely to have better ER as indicated by observer reports, neural indicators of more efficient engagement in ER strategy use, or deployment of a larger number of adaptive ER strategies (Eisenberg et al., 2005; Elsayed et al., 2021; Salmon et al., 2016; R. A. Thompson, 1991). Despite the changing expectations of ER throughout the lifespan, no reviews have systematically examined whether the contributions of certain domains of language (e.g., expressive, receptive) to ER change in accordance with changes in developmentally appropriate ER. As mentioned, however, there is some evidence that expressive language may be particularly salient in the prediction of ER in early childhood (Cole et al., 2004).

There is some indication that normative receptive and expressive language maturation (i.e., improvements in language ability in accordance with development) supports the transition from caregiver-supported ER to autonomous ER (Bendezú et al., 2018; Cole et al.,

2010; Shablack and Lindquist, 2019; R. A. Thompson, 1991). More specifically, there is evidence that language development precedes the use of autonomous calming bids and distraction strategies in toddlers, and that youth with better language are more likely to use self-initiated ER strategies and less likely to rely on external sources for distraction or soothing (Bendezú et al., 2018). Relatedly, there is evidence that language supports the use of linguistically complex forms of autonomous ER, like cognitive reappraisal (i.e., the process of reinterpreting the meaning of an emotional event, often via telling a new “story” about an event) (J. S. Cohen and Mendez, 2009; Sala et al., 2014; R. A. Thompson, 1991). An investigation with preschool-aged youth found that youth with better language ability, in combination with higher GA, used more cognitively complex ER strategies and used them more frequently and successfully (Sala et al., 2014; R. A. Thompson, 1991). Functional neuroimaging work also indicates that during cognitive reappraisal, there is activation in left-lateralized systems of the brain important for language such as the left inferior frontal gyrus (Buhle et al., 2014; Ochsner and Gross, 2008), underscoring the centrality of language to reappraisal, and suggesting that language may serve as a mechanism for ER.

Regarding psychopathology, a recent meta-analysis indicated that poorer language skills were associated with more internalizing problems across childhood and adolescence (Hentges et al., 2021). Factors such as shared associations between language and ER or between poor language and poor executive function, both of which are associated with risk for psychopathology, and shared environmental risk factors that negatively contribute to language and greater psychopathology, such as SESD, are hypothesized to explain associations between language and psychopathology (Salmon et al., 2016). To date, no reviews have examined if specific language domains are more associated with internalizing psychopathology or whether developmental epoch moderates associations between domains of language and internalizing psychopathology (Hentges et al., 2021).

In sum, the small literature indicates that within-individual change in language (e.g., language maturation) and between-individual differences in language are associated with EK and ER, and that poorer language is associated with greater internalizing psychopathology (K. L. Bell and Calkins, 2000; Cole et al., 2010; Hentges et al., 2021; Salmon et al., 2016; R. A. Thompson, 1991). Importantly, despite some indication that certain language domains (e.g., expressive, or receptive) may be more associated with emotion processes (e.g., EK, ER) than others, to date, no reviews have systematically examined this possibility specifically within the context of SESD, or while considering the role of developmental epoch.

1.3.2. Contributions of EF to EK, ER, and internalizing psychopathology

Executive function (EF) undergoes protracted development from infancy to adulthood, and different domains of EF have different developmental trajectories (Bell et al., 2019; Best and Miller, 2010). Broadly, EF development begins in infancy, develops rapidly in the preschool years, has a period of slight regression between ages 11 and 13, and reaches adult-level EF for most individuals between late adolescence and early adulthood (Best and Miller, 2010). Evidence from both behavioral and neuroimaging research indicates that the maturation of EF is a precursor to EK, and that EF facilitates ER throughout development (Bell et al., 2019).

Regarding EK, it is hypothesized that WM and IC are necessary precursors to EK (Martins et al., 2016). Explicitly, before WM and IC have matured, youth cannot hold information regarding their own and other’s emotional states in mind, and without IC youth cannot inhibit their behavior to engage in reflection of others’ emotional states (Martins et al., 2016). Regarding between-individual differences, it is hypothesized that greater ability to hold information in short-term awareness (i.e., recruit WM), and ability to inhibit dominant in favor of subdominant information (i.e., recruit IC) enables better attention in emotion-learning events which enables greater EK (Liew, 2012; Rueda and Paz-Alonso, 2013). Empirically, in early and middle childhood

better EF is associated with better EK (Bacso and Nilsen, 2022; Martins et al., 2016) and EF interventions in preschool improve EK (Q. Li et al., 2020).

Regarding ER, there is evidence that EF development during the preschool period supports development of a larger repertoire of effective autonomous ER strategies and that EF enables youth to shift attention to and from emotion stimuli as necessary for ER (Bell et al., 2019). It is thought that rapid development of IC during the preschool period supports a movement from automatic emotional responding, which is common in infancy, to situationally appropriate emotion suppression (i.e., a form of ER) without the help of a caregiver (Gyurak et al., 2012; Rueda and Paz-Alonso, 2013). Empirically, four year olds with better IC have reduced anger and frustration expression as indicated by parent-report of child temperament (Wolfe and Bell, 2004). In middle childhood, five- to seven-year-olds with higher IC have been found to better regulate their emotion after receiving a disappointing gift, and these relationships continue into early adulthood. Young adults with lower IC are more likely to express their negative emotions relative to their higher IC peers, suggesting worse ER (Bell et al., 2019). Moreover, it is thought that WM supports ER by enabling flexible reappraisal of emotional stimuli (Zelazo and Cunningham, 2007). At three years old, young boys’ WM levels predict their ER abilities, and evidence from across childhood and adulthood suggests that WM capacity is directly associated with ER ability and the specific ability to suppress and reappraise in response to negative emotions (Bell et al., 2019; Malooly et al., 2013). Similarly, CF development is thought to support ER by enabling the redirection of attention toward and away from emotional stimuli; empirically and there is evidence that youth with better CF have better parent-reported ER (Gabrys et al., 2018; Gyurak et al., 2012). Functional neuroimaging research also highlights the importance of brain regions that support EF for ER; engaging in the ER strategy of reappraisal is associated with activation in brain regions, such as the medial PFC, that are known to underlie EF (Bell et al., 2019).

Regarding psychopathology, there is strong evidence that EF impairment is a risk factor for, and consequence of, multiple forms of psychopathology throughout the lifespan in a bidirectional way, such that both greater than average and lower than average EF is associated with increased risk of psychopathology (Romer and Pizzagalli, 2021; Zelazo, 2020). For internalizing psychopathology specifically, there is evidence that lower early life EF is associated with depression and anxiety in later life, and it has been hypothesized that youth with lower levels of EF may have difficulty disengaging attention to negative emotionally salient information which confers risk to internalizing psychopathology (Hawkey et al., 2018; Zelazo, 2020). Like with language, the literature indicates that associations between EF and psychopathology may be attributed to EFs association with ER, shared associations between poor EF and poor language, and shared environmental risk factors that contribute to both low EF and greater psychopathology, such as SESD (Salmon et al., 2016).

In sum, both within-individual maturation in EF, as well as between-individual differences in EF are associated with EK and ER, such that better EF is associated with better EK and ER (M. A. Bell and Wolfe, 2004; Q. Li et al., 2020; Martins et al., 2016). Moreover, the literature indicates that early EF is an important predictor for later internalizing psychopathology, and that EF deficits are both a risk factor for and consequence of internalizing and externalizing psychopathology (Hawkey et al., 2018; Romer and Pizzagalli, 2021; Zelazo, 2020). Despite some indication that certain domains of EF may be more associated with emotion processes than others, and despite knowledge that the demands for emotion processes change throughout the lifespan, to date, no systematic reviews have assessed whether domains of EF contribute to emotion processes (EK, ER) to a differing degree across development, or examined the role of separate contributions of SESD and EF to EK, ER, and psychopathology across development specifically within the context of SESD.

1.3.3. Contributions of GA to EK, ER, and internalizing psychopathology

The lack of specificity around the construct of general intellectual ability and the varied measurements of GA limits generalizations regarding the nature of the relationship between GA and emotion processes. Moreover, unlike language and EF, a course of GA development is not well-documented or delineated, and therefore elucidating how change in GA corresponds with change in emotion processes is more difficult. With these important caveats in mind, there is some evidence that in early and middle childhood, youth with higher GA (i.e., IQ) scores perform better on more complex EK tasks, such as tasks that require youth to recognize the role of beliefs in emotions (Albanese et al., 2010; Bennett et al., 2005; De Stasio et al., 2014). It has been hypothesized that the same central processes assessed by tasks of GA, such as the ability to identify novelty and reason to solve problems involving new information, may help children identify the right emotional cues that represent and communicate the emotion present in an EK task (Albanese et al., 2010).

Similarly, research in adults indicates that individuals with higher GA (i.e., IQ) are better at flexibly and successfully using ER strategies that lead to more effective ER (Opitz et al., 2012). It has been hypothesized that ER partially relies on internal resources, of which GA is one, and that ER strategy selection and success is therefore associated with within and between individual differences in these resources (Opitz et al., 2012). Consistent with this idea, adults with greater GA use a broader range of ER strategies flexibly and successfully, underscoring the contributions of broad cognitive abilities reflected in GA to ER (Malooly et al., 2013; Opitz et al., 2012). Developmentally, there is evidence that youth with higher childhood IQ between the ages five and six use more behavioral and self-reliant forms of ER such as cognitive reappraisal, supporting the importance of cognitive ability to more successful ER (Bendezú et al., 2018; Sala et al., 2014). Moreover, regarding internalizing psychopathology, there is evidence that lower childhood GA is associated with increased risk of symptoms of depression and anxiety in childhood (Leech et al., 2006) and predicts diagnosis of major depression and generalized anxiety in adulthood (Koenen et al., 2009).

1.4. Summary and rationale for review

The literature reviewed above outlines deleterious impacts of SESD exposure on cognition and have highlighted that the deleterious impacts of SESD may accumulate over the course of development (Johnson et al., 2016; Merz, Wiltshire et al., 2019; Perkins et al., 2013b). Moreover, the literature reviewed above indicates that within-individual differences in cognitive functioning contribute to EK, ER, and psychopathology (M. A. Bell et al., 2019; Bendezú et al., 2018; Liew, 2012; Sala et al., 2014; Salmon et al., 2016; R. A. Thompson, 1991). Further, there is evidence that SESD is associated with poorer emotional functioning (i.e., EK, ER and internalizing symptoms and disorders) (Herd et al., 2020; Johnson et al., 2016; Peverill et al., 2021).

When considered collectively, the literature reviewed points toward the myriad ways that cognition and SESD may interact, in terms of relations to emotion and internalizing psychopathology, including mediation, moderation, and independent relationships. For example, given literature highlighting language as precursor to autonomous ER, language may be mechanism (i.e., mediator) explaining associations between SESD and emotion knowledge and regulation. Regarding moderation, it is possible that given the predictive value of EF to psychopathology, SESD may only be associated with greater incidence of internalizing psychopathology only in youth with lower EF. Regarding independent relationships, it is possible that SESD confers independent risk to both emotional and cognitive processes but that this risk is not correlated.

Importantly, the nature of cognition-emotion interactions within the context of socioeconomic disadvantage may differ as a function of developmental epoch (i.e., early childhood, middle childhood,

adolescence), and as a function of when over the course of development an individual was exposed to SESD. To date, no review has systematically examined these potential relationships between SESD and its associated cognitive deficits, to EK, ER, and internalizing psychopathology (IP), or examined these associations at varying stages of development. As such, this review will consider associations between cognitive processes (i.e., language, executive function, general intellectual ability) and emotion processes (i.e., emotion knowledge, emotion regulation, internalizing psychopathology) in the context of SESD throughout development. We will evaluate evidence regarding whether altered cognitive processes mediate or moderate associations between SESD and emotion processes, or whether SESD independently confers risk to both altered cognitive and emotion processes. We systematically review 25 manuscripts that assess the cognitive (i.e., language, EF, and general ability) and emotional processes (i.e., EK, ER and internalizing symptoms and disorders) outlined above, and evaluate evidence for mediation, moderation, and independent associations in the context of SESD.

2. Methods

2.1. Operationalization and scope of key constructs

The breadth of relevant constructs related to socioeconomic disadvantage (SESD), cognition, and emotion has led to inconsistent terminology and operationalization across the literature. The following section will briefly overview the operational definitions of key constructs and their measurement. Of note, although there are many operationalizations of each of the below constructs, we include only the manuscripts which include constructs as defined below.

2.1.1. Socioeconomic status (SES)

There is no consensus on a single definition of socioeconomic status (SES). For the purpose of this review, SES is a multidimensional construct that characterizes “the degree to which individuals are better or worse off in terms of their access to material and social resources” (Olson et al., 2021, p. 1). Accordingly, this review included manuscripts that assessed any metric of SES reflecting individual or group access to resources. Metrics of individual SES include assessments of family educational attainment (i.e., highest level of education attained by a child’s parent or caregiver), caregiver occupation, familial income, or receipt of income support. These metrics can be examined individually or collectively with measures like the Hollingshead Four Factor Index of Social Status which assesses SES based on marital status, retired/employed status, educational attainment, and occupational prestige (Hollingshead, 1975). Other commonly assessed individual metrics of SES include gross income, maternal education and occupation, and income to needs ratios (INR) which quantify familial income relative to the cost of living based on the federal poverty line for the number of people living in a household. According to the United States Department of Health and Human Services, an INR ratio of less than one indicates a family living in poverty, and families living with INR between one and one and a quarter are considered ‘near poverty’ (Shrider et al., 2021). Measures of neighborhood resource access (i.e., neighborhood deprivation) often include metrics of educational, employment, and income deprivation within specific census tracts and are also included in this review. One measure of neighborhood deprivation is the Index of Multiple Deprivation, which classifies the relative area deprivation based on area-level employment education, access to health care, crime, barriers to housing and services, and living environment (Noble et al., 2006). Eligibility for federal aid programs such as Head Start (i.e., a federally funded preschool program) and the special supplemental nutrition program for Women, Infants, and Children (WIC) requires that families be at or below one and a third of the United States federal poverty line (Start, 2000). As such, manuscripts that did not directly assess SES but that included samples accessing these resources were included in this

review. Unless manuscripts included only one indicator of SES, results were described referring only to ‘SES’; specific operationalizations of SES by manuscript are outlined in Table 2.

2.1.2. Cognitive domains

Language The current review focused predominately on receptive (i.e., comprehension of information provided in a variety of ways such as with words, movements, and gestures) and expressive language abilities (i.e., communication of thoughts and feelings through words, gestures, signs, and/or symbols) (McIntyre et al., 2017). Manuscripts that assessed other language components (e.g., phonological processing, semantics) or language-dependent constructs (e.g., reading, spelling) were included if the manuscript aggregated these assessments with assessments of expressive or receptive language. We focused on validated, norm-referenced, performance-based measures of language, but manuscripts that included parent-or-teacher reported language assessed via interview were included if scores were aggregated with performance-based measures.

Assessments of receptive language probe words or phrase recognition using visual or auditory stimuli (McIntyre et al., 2017). One common receptive language task is the picture vocabulary task; youth are asked to identify an image that corresponds to an auditorially presented word. Common picture vocabulary tasks include the NIH Toolbox Picture Vocabulary Test (Gershon et al., 2014) and various versions of the Peabody Picture Vocabulary Test (Dunn and Dunn, 2007). Assessments of expressive language probe language generation of information corresponding to a prompt or a picture (McIntyre et al., 2017). Generally, youth are asked to label a picture or define a word, and common assessments are the Expressive Vocabulary Test (Williams, 1997) and the Expressive One Word Picture Vocabulary Test (Herman, 1994). Observer-reported measures of language include the Vineland Adaptive Behavior Scales (VABS) that assesses both receptive and expressive language using a semi-structured interview (Sparrow and Cicchetti, 1989).

Executive function (EF) Executive function encompasses neuro-cognitive skills that support top-down coordination and control of other brain functions and goal-directed daily actions (Zelazo, 2020). There is neural and behavioral evidence for both “cool” EF skills, which involve conscious control of thoughts and actions without an affective component (Poon, 2018), and more “hot” EF skills activated in more emotional contexts (Poon, 2018; Zelazo, 2020). Because this review examines the influence of cognitive abilities on emotional processes, manuscripts highlighting “hot” EF that involve goal-directed, future-oriented cognitive processes elicited in contexts that generate emotion have been excluded, as it would be difficult to distinguish between the generation of emotion and the effects on emotion (Poon, 2018). Accordingly, this review included manuscripts that focused on the contributions of aspects of “cool” EF – cognitive flexibility (CF) (i.e., the ability to switch between thinking about two different concepts or to think about multiple concepts simultaneously), inhibition/inhibitory control (IC) (i.e., the ability to inhibit a prepotent or automatic response), working memory (WM) (i.e., capacity to keep and manipulate information in the mind), and attentional control (AC) (i.e., The ability to focus or sustain attention on a given task voluntarily) (Bailey et al., 2018; Jones et al., 2016; McCoy, 2019; Poon, 2018). Moreover, in order to broaden the range of manuscripts reviewed, and given recent literature which identifies self-regulation (SR) (i.e., a broad set of both conscious and unconscious processes that control, modulate, inhibit, initiate internal states and observable behavior) as an epiphenomenon of EF, manuscripts that included assessments of SR were also included (McCoy, 2019). Many of the manuscripts included in this review examined summary scores of EF that included measures of WM, IC, CF, and AC, in addition to other facets of EF. Various methodologies have been used to assess EF and SR, including performance-based tasks and multi-informant rating scales, and this review included manuscripts that used both.

Tasks of IC often employ paradigms that require youth to suppress

the tendency to produce a dominant response. These include the Day/Night Task (Gerstadt et al., 1994; Montgomery and Koeltzow, 2010); youth are asked to say ‘night’ when they see a sun and ‘day’ when they see a moon, and other versions of the Go/No-go tasks in which youth are asked to respond contrary to their prepotent responses (e.g., Grass/Snow, Bear/Dragon) (Bailey et al., 2018). Dual-task paradigms are often used to assess WM; youth must hold and manipulate two or more things in mind (Bailey et al., 2018; McCoy, 2019). One such task is the Peg Tapping Task (Diamond and Taylor, 1996); youth comply with two separate rules about when to tap a peg on the table (i.e., tap once when experimenter taps twice, tap twice when experimenter taps once). Measures of CF and AC often include rule-use tasks in which the terms of the task change, such as the Dimensional Change Card Sorting task (Zelazo, 2006); youth are instructed to sort cards by different rules at different points in the task and the Head-Toes-Knees-Shoulders task (Gonzales et al., 2021) in which youth are instructed to touch different body parts at different points in the task (Gonzales et al., 2021). Informant measures of EF and SR include the Behavior Rating Inventory of Executive Function (BRIEF) (Gioia et al., 2000) and the Preschool Self-Regulation Assessment (Smith-Donald et al., 2007). Table 1 includes a summary of all included EF measures.

General Ability (GA) General ability, otherwise known as general intelligence or intelligence, refers to a multifaceted construct indexing an individual’s verbal and non-verbal abilities and is believed to underlie individual skill in handling a myriad of intellectual tasks. Assessments of GA are norm-referenced and validated and typically include multiple assessments of both verbal and non-verbal abilities. Some assessments of GA also include facets of WM and processing speed (i.e., speed with which information can be sensed, perceived, understood, and responded) but others do not (Raiford et al., 2005; Saklofske et al., 2006). GA is often assessed with the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) for children between the ages of three and six and the Wechsler Intelligence Scale for Children (WISC) for children between the ages of six and 16 (Kaufman et al., 2015; Lichtenberger and Kaufman, 2004).

2.1.3. Emotion domains

Emotion knowledge (EK) Emotion knowledge tasks assess the ability to identify and understand emotion in facial expressions, behavioral cues, and situational context (Izard et al., 2011). The current review focused on performance-based measures of EK, including tasks of emotion labelling (i.e., naming of facial expression corresponding to images) and emotion situation knowledge (i.e., report emotional responses to different situations based on social context cues alone). Some standard measures include the Affect Knowledge Test (AKT) and the Preschool Emotion Interview (PEI) (Denham, 1986; Garner et al., 1994). For both, youth complete various tasks that require them to label pictures of an emotion, name an emotion that corresponds with a provided face, and match an emotion with a vignette.

Emotion regulation (ER) There is no consensus on the definition, scope, or operationalization of emotion regulation, and numerous reviews have outlined the corresponding causes and consequences of the definitional and operational imprecision surrounding ER (Bridges et al., 2004; Cole et al., 2004; Gross, 1998; Gross and Feldman Barrett, 2011). For the sake of this review, ER “refers to the things done to influence which emotions are experienced, when they are experienced, and how they are experienced and expressed” (Gross, 1998). In early and middle childhood, ER is often measured with observational or observer-report methods because very young children have considerable difficulty reflecting on and reporting their emotional experiences (Cole et al., 2004). Accordingly, the measures included in this review are based on observer reports. Although there are various methods for assessing ER, manuscripts identified for this review focused on the Emotion Regulation Checklist (ERC) and responses to the Disappointing Gift Task and the Not Sharing Task. The ERC is a 24-item observer-report (parent or teacher) questionnaire assessing youth’s (ages 6–12) intensity, lability,

Table 1
Measures of Cognitive and Emotion Domains.

Construct	Measure & Description
Expressive Language	<p>Renfrew Bus Story: Examinee tells story about a bus from a picture book</p> <p>Expressive Vocab Test (EVT) (Pankratz et al., 2007; Williams, 1997): Examinees are shown a picture and are asked to say aloud the name of the picture/ A second type of item presents a picture and a word, and are asked to respond with a synonym</p> <p>Stanford–Binet Intelligence Scales: Vocabulary subtest (Roid and Pomplun, 2012): Examinee are asked to describe a picture or define a word</p> <p>British Ability Scales (BAS) (Hill, 2005): Naming Vocabulary subtest: Examinees are shown series of picture and asked to name them</p> <p>Expressive One-Word Picture Vocabulary test (Herman, 1994): Examinee are shown series of drawings and are asked to identify the objects depicted</p> <p>Test of Language Development (TOLD): Sentence Imitation subtest (Newcomer and Hammill, 2008): Examiner reads a sentence aloud and asks examinee to repeat it</p> <p>TOLD: Relational Vocabulary subtest (Newcomer and Hammill, 2008): Examinees identify relationships between two words</p> <p>TOLD: Oral Vocabulary subtest (Newcomer and Hammill, 2008): Examinees asked to define predefined words</p> <p>TOLD: Grammatical Completion subtest (Newcomer and Hammill, 2008): Questions are asked to assess examinees understanding of a variety of sentences</p> <p>Woodcock-Johnson III Tests of Achievement (WJ-III): Picture Vocabulary subtest (Woodcock, 1997): Examinees asked to name objects in a series of pictures</p> <p>Woodcock–Johnson Psycho-Educational Battery–Revised Test of Achievement (WJ-R) (Woodcock, 1997): Oral language subtest: Examinees complete tasks of listening comprehension, oral expression, and auditory memory span</p> <p>McCarthy Scales of Children’s Abilities (MSCA) (Lynch et al., 1982): Verbal Fluency subtest: Examinees name as many items within a category within a time limit</p> <p>MCSA: Opposite Analogies subtest (Lynch et al., 1982): Examinees complete statements comparing two items</p> <p>Wechsler Intelligence Scale for Children (WISC): Vocabulary subtest (Kaufman et al., 2015): Examinees define words</p>
Receptive Language	<p>National Institutes of Health (NIH) Toolbox Picture Vocab Test (TPVT)(Weintraub et al., 2013): Examinees identify images corresponding to an orally presented word</p> <p>Peabody Picture Vocab Test (PPVT) (Dunn and Dunn, 2007): Examinees point to pictures that correspond to the stimulus word among plates of four pictures</p> <p>TOLD: Grammatical Understanding subtest (Newcomer and Hammill, 2008): Examiner reads a sentence aloud and asks the examinee to choose one of four pictures that best matches the content of the sentence</p> <p>Wechsler Preschool and Primary Scale of Intelligence (WPPSI): Receptive Vocab subtest: (Lichtenberger and Kaufman, 2004) Examinee asked to identify an item corresponding to an auditorally presented words</p> <p>Vineland Adaptive Behavior Scales (VABS): Receptive Communication (TR)(Sparrow and Cicchetti, 1989): standardized interview tool that uses semi-structured interview to assess receptive language skills</p>
Broad Language	<p>MSCA (Lynch et al., 1982):: Pictorial Memory, Word Knowledge, Verbal Memory</p> <p>Wide Range Achievement Test-Revised Edition (WRAT): Reading, Spelling tests</p>

Table 1 (continued)

Construct	Measure & Description
General Ability	<p>WPPSI/WISC: Information subtest: (Kaufman et al., 2015;Lichtenberger and Kaufman, 2004) Youth asked to identify similarities between two tasks</p> <p>VABS: Written Communication Domain (PR, TR) (Sparrow and Cicchetti, 1989): standardized assessment tool that utilizes semi-structured interview to assess written communication skills of the examinee</p> <p>BAS (Hill, 2005):: Word Reading subtest: Examinee asked to read words</p> <p>Kaufman Brief Intelligence Scale (Kaufman, 1990)</p> <p>Wechsler Abbreviated Scale of Intelligence (WASI), WISC, WPPSI</p> <p>BAS (Hill, 2005): Naming Vocab, Pattern Construction, Picture Similarities, Word Reading</p> <p>Bracken School Readiness Assessment (Bracken et al., 1984): School Readiness Composite</p>
Executive Function (EF)	<p>Preschool Self-Regulation Assessment (PRSA), Pencil Tap subtest (Smith-Donald et al., 2007): Children asked to tap their pencil once when the examiner tapped twice and twice when the examiner tapped once (IC)</p> <p>PRSA: Balance Beam (Smith-Donald et al., 2007):: Examinee instructed to walk a long line once, and to walk the same line slowly (IC)</p> <p>PRSA: Tower Turn-Taking: (Smith-Donald et al., 2007): Examinee builds a very high tower with blocks taking turns with assessor (IC, SR)</p> <p>Grass/Snow (Bailey et al., 2018): Examinee instructed to say “snow” to the grass cards and “grass” to the snow cards. (IC)</p> <p>Children’s Behavior Questionnaire (Bailey et al., 2018):: Parent report measure of early to middle childhood temperament including dimension of Effortful Control (Composite EF)</p> <p>Bear/Dragon (Bailey et al., 2018): Examinee instructed to say “bear” to the dragon cards and “dragon” to the bear cards. (IC)</p> <p>NEPSY (A Developmental NEUROPSYCHOLOGICAL Assessment): Auditory Attention subtest (Brooks et al., 2009): Assess selective auditory attention and the ability to sustain it (IC, AC, CF)</p> <p>NEPSY: Inhibition subtest (Brooks et al., 2009): : assesses the ability to inhibit automatic responses in favor of novel response (IC, CF, WM)</p> <p>Day/Night (Bailey et al., 2018): Examinee instructed to say “day” to the black cards and “night” to the white cards (IC)</p> <p>The Dimensional Change Card Sort (Zelazo, 2006): After sorting cards according to a certain dimension (e. g., color), examinee required to begin sorting according to a different dimension (e.g., shape), followed by a mixed trial in which shape and color are offered in a pseudo random order (Composite EF)</p> <p>Head-Toes-Knees-Shoulders (Gonzales et al., 2021): Examinee asked to learn simple commands (i.e., “touch your head,” “touch your toes”) then do the opposite of what the assessor said (e.g., touch their toes when asked to touch their head). (Composite EF)</p> <p>Behavior Rating Inventory of Executive Function (BRIEF) (BR)(Bailey et al., 2018): This 86-item PR questionnaire asks parents to rate their children’s everyday behavioral examples of EF (SR, Composite EF)</p> <p>Emotional Stroop (Bailey et al., 2018): Examinee asked to categorize a facial expression as happy or scared, while ignoring a word (i.e., “Happy” or “Fear”) overlaid on the facial expression (IC)</p> <p>Backward Word Span (Bailey et al., 2018): Examinee hears a list of words read aloud and are asked to repeat the words, but in reverse order (WM)</p> <p>Pick the Picture (Bailey et al., 2018): Examinee asked to consistently choose pictures from a set that they have not chosen before, holding in mind those they had already picked (WM)</p> <p>Animal Go/No-Go (Pig) (Bailey et al., 2018):: As pictures of animals flashed on screen, examinee asked to touch all of the animals except for the pig. (IC)</p>

(continued on next page)

Table 1 (continued)

Construct	Measure & Description
	<p>Something's the Same (Bailey et al., 2018):: Screen displayed two pictures that were similar on one dimension (e.g., color, size), and then added another picture that was the same as one of the first pictures in a different way. Examinee asked to choose which of the first two pictures was like the new picture (e.g., shift to think about similarity on a different dimension) (CF)</p> <p>The Leiter-Revised Attention Sustained Subtest (Roid and Miller, 1997): Examinee shown a target figure (e.g., flower) located at the top of the stimulus and were instructed to scan an array of figures and cross out all of the target figures as quickly as they can (AC/CF)</p> <p>Peg Tapping (Bailey et al., 2018): Examinee instructed to tap a wooden dowel twice when the experimenter tapped once and to tap once when the experimenter tapped twice (IC)</p> <p>Developmental Indicators for the Assessment of Learning-Third Edition (DIAL-3)(Strawser and Sileo, 1999): Research staff rated 9 aspects of examinee's behaviour during assessments. The self-regulation measure incorporated the primary rater's ratings on 3 behaviour items: attention, activity level, and impulsivity (SR)</p> <p>Visual-spatial IC task (Vaughn-Coaxum et al., 2020) vau: Participants viewed a fixation cross in the center of the screen followed by an array of 16 circles with combinations of red (target) and yellow (distractor) stars inside four different circles. Participants were instructed to remember the location of the red target stars and ignore yellow distractors. In the inhibition trials, cognitive load was static; participants needed to encode the location of two red target stars and ignore the location of two yellow distractor stars. (IC)</p> <p>Visual-spatial WM task (Vaughn-Coaxum et al., 2020): Participants viewed a fixation cross in the center of the screen followed by an array of 16 circles with combinations of red (target) and yellow (distractor) stars inside four different circles. Participants were instructed to remember the location of the red target stars and ignore yellow distractors. Working memory capacity was defined as accuracy on trials with four red targets (high load, no distractors) controlling for accuracy on trials with only two targets. (WM)</p>
Emotion Knowledge	<p>Expression Recognition Task (Ceciliono et al., 2017): Examinee identified emotional faces at differing intensity of emotional expression</p> <p>Assessment of Children's Emotional Skills (Izard et al., 2003): Examinee labeled and matched emotion words to emotion faces, situations, and vignettes</p> <p>Emotion Recognition Questionnaire (Camras et al., 1988): Examinee listened to 16 very short stories describing characters in emotionally evocative contexts and identified the characters' feelings by pointing to pictures of happy, mad, sad, or scared faces.</p> <p>Emotion Expression Knowledge and Emotion Situation Knowledge Task (Izard et al., 2003): Examinee labeled and matched emotion words to emotion faces, situations, and vignettes</p> <p>Preschool Emotion Interview (Denham, 1986; Ursache et al., 2019): Examinee labelled pictures of facial expressions, were asked to identify how the character in the story felt after a story and were asked to identify an emotion in a puppet after a situation.</p>
Emotion Regulation	<p>Not sharing Task, Disappointing Gift Task (Goldsmith and Rothbart, 1993): See Methods</p> <p>Emotion Regulation Checklist (PR, TR)(Shields and Cicchetti, 1997): See Methods</p>
Internalizing Psychopathology	<p>Revised/Preschool Behavior Questionnaire (Bornstein et al., 2013): Parent or Teacher Report measure of Children's behaviors</p> <p>Children Behavior Checklist/Youth Self Report/Teacher Report Form (Van Meter et al., 2014): The CBCL, YSR, and TRF are 113 item questionnaires that assess the presence of symptoms of behavioral, emotional and conduct symptoms in past six months.</p>

Table 1 (continued)

Construct	Measure & Description
	<p>Children's Depression Inventory (SeR, PR) (Smucker et al., 1986): Questionnaire that assesses frequency of depression symptoms over the past two weeks.</p> <p>State-Trait Anxiety Inventory, Form C-2 (SeR) (Piatka, 1987): Questionnaire that assesses trait and state anxiety with 20 items that asks children to rate frequency of anxiety symptoms.</p> <p>The Loneliness Scale (SeR) (De Jong-Gierveld and Van Tilburg, 1990): Assesses childhood loneliness with 16 items.</p> <p>Differential Emotions Scale, form IV (SeR) (Boyle, 1984): Questionnaire which measures children's experience of emotions related to internalizing behaviors</p> <p>SDQ (PR, TR) (Goodman, 2001): See Methods</p> <p>School Readiness Survey (TR) (O'Donnell, 2008): Teacher report questionnaire assessing emotional and behavioral symptoms in youth</p> <p>Developmental and Well-Being Assessment (DAWBA) (Aebi et al., 2012): Interview with parents assessing specific DSM disorder criteria</p> <p>Preschool and Kindergarten Behavior Scales (TR) (Merrell, 1994): Questionnaire assessing social skills and problem behaviors during the past month in 3-6-year-old children</p> <p>Behavior Assessment System for Children (TR, SeR, PR)(Reynolds, 2010): Questionnaire which asks caregivers to rate frequency of 100 different Children behaviors, assesses emotional and behavior problems</p> <p>Ontario Children Health Study (OCHS) scales (PR)(Boyle et al., 1993): Questionnaire which assesses symptoms of disorders corresponding to the DSM</p> <p>Brief Infant-Toddler Social and Emotional Assessment (PR) (Briggs-Gowan et al., 2001). Questionnaire of social-emotional/behavioral problems and delays in social-emotional competence in 12-36-month-olds</p>

Abbreviations: IC, inhibitory control; WM, working memory; CF, cognitive flexibility; SR, self-regulation; AC, attentional control; TR, teacher-report; SeR, self-report; PR, parent-report.

flexibility, and appropriateness of the child's positive and negative ER (Shields and Cicchetti, 1997). The Disappointing Gift Tasks (DGT) and Not Sharing Task (NST) from the Laboratory Temperament Assessment Battery assess the intensity of a child's emotional display and behavioral reactions during in-lab paradigms after receiving a non-preferred gift or in response to unfairness (Goldsmith and Rothbart, 1993). ER is rated by trained observers who view youth's responses and indicate overall emotional display and tolerance for distressing emotions. The ERC, DGT, and NST have all been used extensively in the developmental ER literature (Goldsmith and Rothbart, 1993; Patel, 2018; Tobin and Graziano, 2011).

Internalizing psychopathology Internalizing disorders are characterized by disturbances in emotions and moods and include disorders characterized by anxiety, depression, somatic complaints, and withdrawal (Zahn, Waxler et al., 2000). This review focused on both diagnostic internalizing disorders and subclinical internalizing symptomology (IP) assessed by self-or-observer reports or validated clinical interviews for the diagnosis of internalizing disorders.

Assessment of IP in early childhood relies on observer reports because young children have considerable difficulty reflecting on and reporting their emotional experiences (Cole et al., 2004). In middle childhood and adolescence, assessment of IP can include youth self-report. Common parent-report measures of internalizing symptoms include the Strengths and Difficulties Questionnaire (SDQ), an emotional and behavioural screening questionnaire that quantifies internalizing symptoms in isolation or together with behavioral symptoms in four to 16 year olds (Goodman, 2001), and the Brief Infant-Toddler Social-Emotional Assessment (BITSEA) internalizing

scale that assesses symptoms of depression, anxiety, and negative emotionality items in one to three year olds (Briggs-Gowan et al., 2004). Common youth self-report measures include the Children's Depression Inventory, which assesses the cognitive, affective, and behavioral signs of depression in children and adolescents between the ages of seven and 17 (Kovacs, 2014), and the State-Trait Anxiety Inventory for Children State form, which assesses trait anxiety and state anxiety in seven- to nine-year-olds (Spielberg et al., 1973). Common teacher report assessments include the Preschool Behavior Questionnaire (PBQ) and the Revised Preschool Behavior Questionnaire (RPBQ) which assess symptoms of emotional problems in three- to six-year-olds (Behar, 1977). The Achenbach instruments for assessing emotional and/or behavioral problems is a very commonly used measure to assesses internalizing, externalizing and other psychopathology symptoms and quantifies symptoms relative to age-and-gender based norms. The Achenbach instruments include a parent-report measure (i.e., Child Behavior Checklist (CBCL), a self-report measure (i.e., Youth Self-Report (YSR)), and a teacher-report measure (i.e., Teacher report Form (TRF)) (Achenbach, 1997; Kendall et al., 2007).

Diagnostic assessments of internalizing psychopathology often include semi-structured clinical interviews with parents and children that assess specific disorder diagnostic criteria. One common measure is the National Institute of Mental Health Diagnostic Interview Schedule (DIS) for the DSM-IV which is a semi-structured interview assessing symptoms of symptomology relative to DSM criteria (Compton and Cottler, 2004). Table 1 includes a summary of all included psychopathology measures.

3. Literature search and selection criteria

A systematic search of relevant articles was conducted from August 2021 to September 2021 using PubMed and PsycInfo databases. Articles were required to be original, quantitative research published in a peer-reviewed journal that included measures of SESD or which was compromised of a SESD sample, and that included relevant measures of cognition and emotion or IP. Additional inclusion criteria were a sample of youth with a mean age between one and seventeen at the time of assessment, or for whom an outcome measure was assessed during this timeframe and published between the years 1990–2021. Given evidence that negative associations between EF and SES do not hold in all non-Western, Educated, Industrialized and Rich Countries (Howard et al., 2019) studies must also have been conducted in (WEIRD) countries. Studies were excluded for the following reasons: studies did not contain relevant measures of cognition or emotion, all measures were based on observer-report, studies where the relationship between SES and emotion/cognition were not evaluated, or where associations between emotion and cognition were not evaluated, study sample included only children with developmental disabilities or organic medical conditions that impact cognition, studies included samples were of primarily bilinguals, studies of children with documented exposures to elicit substances that influence cognition, studies were conducted in non-WEIRD countries, and unoriginal research.

3.1. Search strategy

Separate search strings were used for each cognitive variable and the emotion and psychopathology constructs. The following combinatory keyword was used across all selected search engine for SES: income or disadvantage or socioeconomic* status or poverty or deprivation or impoverish* , and either emotion: emot* or emotion or depress* OR anxiety OR anxious OR internalizing for internalizing psychopathology. The search terms for cognition included cognit* or neuropsychol OR executi* or executive function* OR * OR language OR "cognitive flexibility" or "working memory" or "inhibitory control" OR "IQ" or "general ability" OR "intelligence". We further limited results by including a cue word for age including "children OR infant OR youth OR adolescents OR

pediatric OR child".

3.2. Data extraction and synthesis

Abstracts were retrieved from the databases and uploaded into Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia) and reviewed by the first author (NME) for inclusion/exclusion. Additional articles retrieved from the reference lists of articles were also reviewed. Each abstract was reviewed to ensure inclusion of measures pertaining to the relevant variables and to confirm that studies included outcomes during the studies proposed timeframe. The following information was extracted: year of publication, country, sample characteristics (e.g., sample size, child age, child sex), independent and dependent variables, measures, and main outcomes related to cognition, emotion, and psychopathology.

3.3. Study selection

5445 references were imported for screening and an additional study was identified from reference lists and was screened. After removing duplicates (n = 2078), 3368 studies were screened against title and abstract, of which 3174 irrelevant studies were excluded. Of the remaining 194 studies assessed for full-text eligibility, 169 studies were excluded: 69 contained no measure of cognition or emotion, 59 did not assess relationships between emotion outcomes and cognition, 15 were unoriginal research, 11 were conducted in adult populations, eight were written in languages other than English, four contained all parent or self-reported measures, and three were conducted in samples from non-WEIRD countries, yielding a final sample of 25 manuscripts (Fig. 1).

3.4. Study characteristics

Manuscripts included were summarized by developmental epoch based on the age at which the outcome variable was assessed. If a manuscript contained multiple outcome variables assessed across developmental epochs, it was classified as pertaining to both epochs. As such, of the 25 manuscripts, 13 were conducted with youth in the early childhood period (i.e., mean sample age > one year of age but ≤ six years of age), six in middle childhood (i.e., mean sample age > six years of age but < 11 years of age), and three in adolescence (i.e., mean sample age ≥ 11 years of age but < 18 years of age), one spanned early childhood and middle childhood, and two spanned middle childhood and adolescence. Within each developmental epoch, manuscripts were summarized based on the emotion domain (i.e., emotion knowledge, emotion regulation, internalizing symptomology) and cognitive domain (i.e., language, executive function, general ability) assessed; manuscripts were examined in more than one emotional or cognitive section as appropriate (see Table 2). In total, 13 studies examined the contributions of EF to emotion outcomes (Denham et al., 2012; Farrell and Gilpin, 2021; Lengua et al., 2015, 2020; McNeilly et al., 2021; Nelson et al., 2011; Reilly and Downer, 2019; Rhoades et al., 2009; Ursache et al., 2019; Vaughn-Coaxum et al., 2020; Wade et al., 2021), 14 studies examined contributions of language to emotion outcomes (Bornstein et al., 2013; Elsayed et al., 2021; Fine et al., 2003; Flouri et al., 2010, 2012, 2014; M. Li et al., 2017; Nelson et al., 2011; Reilly and Downer, 2019; Rhoades et al., 2009; Schultz et al., 2001; Tan and Dobbs-Oates, 2013; Wade et al., 2021), and five examined contributions of GA to emotion outcomes (Elsayed et al., 2021; Erhart et al., 2019; Flouri et al., 2015; Martin et al., 2007; Owens et al., 1999). Across developmental epoch and cognitive domains, a majority (N = 15) of studies examined internalizing psychopathology (Bornstein et al., 2013; Fine et al., 2003; Flouri et al., 2010, 2012, 2014, 2015; Lengua et al., 2015, 2020; Martin et al., 2007; McNeilly et al., 2021; Owens et al., 1999; Rhoades et al., 2009; Tan and Dobbs-Oates, 2013; Vaughn-Coaxum et al., 2020; Wade et al., 2021), seven papers examined EK as the emotional outcome (Denham et al., 2012; Erhart et al., 2019; Farrell and Gilpin, 2021;

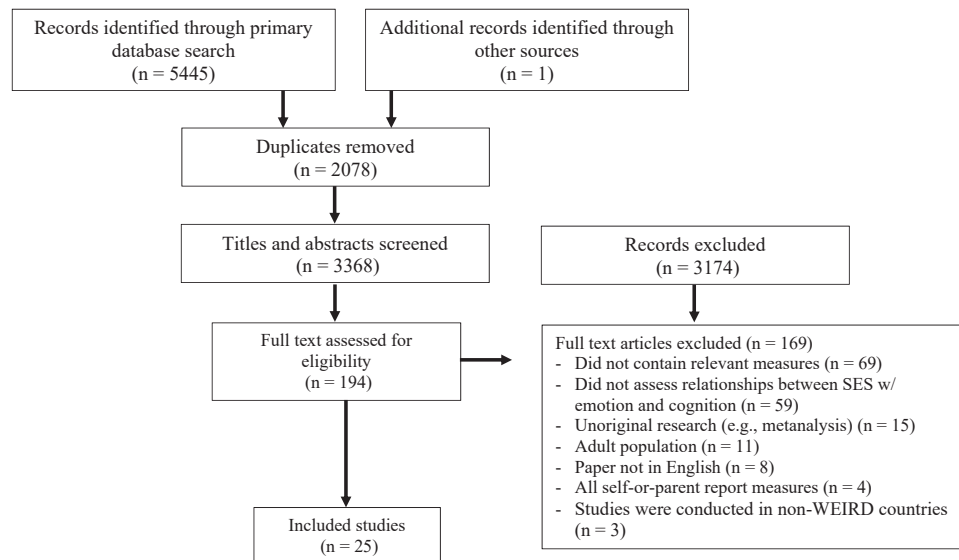


Fig. 1. PRISMA Flow Chart of Literature Search and Selection.

Nelson et al., 2011; Schultz et al., 2001; Ursache et al., 2019), and the remainder examined ER (N = 3) (Elsayed et al., 2021; M. Li et al., 2017; Reilly and Downer, 2019).

Across developmental epochs, 19 studies were conducted in the US, five studies were conducted in the UK, of which four were from the Millennium Cohort Study (MCS), and one in Canada. Of the 25 studies, a majority included youth across the socioeconomic spectrum (N = 16), nine studies included youth who were all disadvantaged, one study oversampled for disadvantaged youth, and the remaining study was oversampled for economic advantage. One study contained only boys (Owens et al., 1999); the rest contained both boys and girls. Characteristics and main outcomes of each study are summarized in Table 2 within developmental epoch by the emotional (i.e., EK, ER, internalizing symptomatology) and cognitive variables (i.e., language, EF, GA) assessed.

4. Results

4.1. Contributions of language and SES to emotional outcomes

4.1.1. Early childhood: contributions of language and SES to emotional outcomes

EK. Two studies examined associations between language, SES, and EK, and both indicated that better language was associated with better EK (Cutting and Dunn, 1999; Nelson et al., 2011). Nelson et al. (2011) reported that among a group of 336 SESD children (M age = 55 months) enrolled in Head Start, youth with better expressive and receptive language abilities had better EK. Similarly, Cutting and Dunn reported that among a group of 128 children (M age = 4.16), better language ability (i.e., an average of both expressive and receptive), but not SES, was associated with greater EK. Importantly both studies' assessed language using via standardized performance-based norm-referenced language measures, and both EK tasks included recognition of emotions on faces considering environmental context (see Table 1).

ER. Two studies examined associations between SES, language, and ER. One of these studies reported that neither language nor SES contributes to ER (M. Li et al., 2017) and one reported that language assessed via standardized norm-referenced language measures, but not SES, contributes to ER (Reilly and Downer, 2019). Importantly both studies' assessed language using via standardized performance-based norm-referenced language measures, but assessments of ER differed. Implications for these methodological differences will be discussed in the conclusions section.

Internalizing psychopathology. Four studies reported on associations between language, SES, and IP. All studies' assessed language using via standardized performance-based norm-referenced measures and IP with scales of parent-reported youth behaviors and affect. Amongst studies with samples representing continuous distributions of SES, two indicated that both expressive language and SES additively and independently contributed to IP (Flouri et al., 2010, 2012), and one indicated that receptive language assessed via a standardized norm-referenced measure did not contribute to IP after accounting for SES (Wade et al., 2021). Amongst samples that were predominately SESD, one indicated that receptive language independently contributed to IP (Rhoades et al., 2009), and one reported mixed associations between SES, language, and IP, with moderation by demographic factors (Tan and Dobbs-Oates, 2013).

4.1.2. Middle childhood: contributions of language and SES to emotional outcomes

EK. A longitudinal study of 143 SESD youth enrolled in Head Start reported that greater receptive language ability assessed using standardized performance-based norm-referenced measures of language in preschool (M age = 4.9) was associated with better EK task performance in first grade (M age = 6.9) (Schultz et al., 2001).

ER. No studies met criteria.

Internalizing psychopathology. Of the three studies which examined associations between SES, language, and IP in middle childhood, one reported that lower SES and poorer language independently and additively contributed to greater IP (Flouri et al., 2014), one reported that language, but not SES, prospectively and independently contributed to IP (Bornstein et al., 2013), and one reported that neither language nor familial income contributed to IP (Fine et al., 2003). All studies' assessed language using via standardized performance-based norm-referenced measures and assessed IP with scales of parent or youth-reported behaviors and affect.

4.1.3. Adolescence: contributions of language and SES to emotional outcomes

EK. No studies met criteria.

ER. In adolescence, only one study examined associations between familial income, language abilities, and ER in adolescence and reported that lower early-life INR (M age = 4.55) predicted worse parent-reported adolescent ER (M age = 16.31) and that lower receptive language ability, assessed using via standardized performance-based norm-referenced measures, partially mediated the association between INR

Table 2
Results of Study by Developmental Epoch.

Authors	Epoch	Sample Characteristics Mean (M)	Cognitive Domain	Emotion Domain	All SESD?	SES Metric	Results
Elsayed et al. (2021)	A	Longitudinal, N = 139, T1 M age = 4.55, T9 = 16.31	Language: Receptive, GA	ER (PR)	No	INR	↓ INR and ↓ language associated w/ ↓ ER
Vaughn-Coaxum et al. (2020)	A	N = 117, M age = 12.74	EF: Composite EF	P: Depression Symptoms (PR, SeR)	No	INR, PE	WM, IC, SES not independently associated w/ depression. IC moderated associations between SES and depression symptomatology.
McNeilly et al. (2021) (Study 2)	A	N = 259, M age = 12.6	EF: Composite EF, IC, AC	P: IP (PR, SeR)	No	INR, PE, living below the poverty line, food insecurity	Some SES indicators related to ↑ IP, ↓ IC was associated w/ ↑ IP, ↓ SES by four SES indicators associated w/ ↓ IC. No mediation by EF
McNeilly et al. (2021) (Study 1)	A	N = 94, M age = 13.57	EF: SR, composite EF, IC, AC	P: IP (PR, SeR)	No	INR, PE, living below the poverty line, food insecurity	Some indicators of SES related to greater self-and-parent-reported IP and lower parent-reported composite EF. ↓ EF partially mediated associations between ↓ INR and ↑ IP
Reilly and Downer (2019)	EC	Longitudinal, N = 380, M age T1 = 52.50 months, two other assessments approximately 3 months later	Language: Expressive & Receptive, EF: Composite EF	ER (TR)	No, but oversampled for poverty (75.30% of sample had INR ≤ 2)	INR	↑ language, but not EF, predicted ER even after controlling for INR. EF & language interacted in the prediction of ER even w/ INR included. When children entered preschool w/ high EF, ER was similar regardless of language
Ursache et al. (2019)	EC	Longitudinal, N = 1034, M age (years) T1 = 4.3, T2 = 4.9, T3 = 5.7	EF: SR	EK	Yes	Children living in an area where the schools have kids with 70% of kids are eligible for free and reduced lunch, Parent education	↑ EF associated w/ ↑ EK at T1, but EF not related to growth in EK between T1 and T2.
Wade et al. (2021)	EC	N = 501, ages 2, 18, and 36 months	Language: Receptive, EF: IC	P: IP (PR)	No	Income & assets	↓ SES associated w/ ↑ IP; EF & Language not related
Nelson et al. (2011)	EC	N = 336, M age = 55 months	Language: Expressive & Receptive, EF: WM	EK	Yes	Head Start enrollment	WM not associated with EK, ↑ Language associated w/ ↑ EK
Denham et al. (2012)	EC	Longitudinal N = 322, M age (months) T1 = 49.4, T2 = ~ 53	EF: Composite EF	EK	No	Head Start enrollment vs Private Preschool	↑ T1 EF was associated w/ ↑ T1 EK for all, T1 fall EF only predicted ↑ T2 EK in economically advantaged
Rhoades et al. (2009)	EC	N = 146, M age = 54 months	Language: Receptive, EF: IC, AC	P: IP (TR)	Yes	Head Start enrollment, ME & MO	↓ receptive language associated w/ IP, mixed evidence regarding EF; some measures of IC related, and others not related. Neither maternal education nor occupation were associated w/ IP after accounting for IC.
Flouri et al. (2012)	EC	Longitudinal, N = 9736, Assessed at 9 months and 3 years	Language: Expressive, Receptive	P: IP (PR)	No	Household overcrowding, not owning the home, receipt of income support, and income poverty, neighbourhood median income	↓ SES & ↓ expressive language ability associated w/ ↑ IP. Neighborhood deprivation was not independently associated w/ emotional problems after accounting for SES, language. Moderation: ↑ expressive language dampened the contributions neighborhood deprivation, but not SES, to greater emotional symptoms
Tan and Dobbs-Oates (2013)	EC	N = 146, M age = 46.6 months	Language: Expressive, Receptive	P: Depression/ Anxiety/ Withdrawal Symptoms (TR)	Yes	Housing and Urban Development definition of low to extremely low income	↑ expressive language related to ↓ withdrawal symptoms; Associations between receptive/ expressive and anxiety/

(continued on next page)

Table 2 (continued)

Authors	Epoch	Sample Characteristics Mean (M)	Cognitive Domain	Emotion Domain	All SESD?	SES Metric	Results
Flouri et al. (2010)	EC	Longitudinal, N = 9736, Assessed at 9 months and 3 years	Language: Expressive, Receptive	P: IP (PR)	No	Household overcrowding, not owning the home, receipt of income support, and income poverty.	depression symptoms moderated by demographics ↓ SES & ↓ Expressive language ability associated w/ ↑ IP
Lengua et al., (2015, 2020)	EC	Longitudinal, N = 306, assessed four times between 36 and 40, 45–49, 54–58, and 63–67 months	EF: Composite EF	P: IP (TR)	No	Income	Income not associated w/ IP after accounting for EF. No mediation by EF
Li et al. (2017)	EC	N = 140, M age = 65.5 months	Language: Receptive	ER	No	Income, ME	Neither Language nor SES associated with ER
Cutting and Dunn (1999)	EC	N = 128, M age = 4.16 years	Language: Expressive, Receptive	EK	No	PE & PO	↑ Language contributed independently to ↑ EK, SES not associated
Farrell and Gilpin (2021)	EC, MC	Longitudinal, N = 531, Mean age (months) T1 = 55, T2 = 61, T3 = 70, T4 = 81	EF: IC	EK	Yes	Head Start enrollment, income	IC and EK bidirectionally related in early childhood but not middle childhood; Income not independently associated w/ EK
Owens et al. (1999)	MC	Longitudinal, only boys, N = 310, ages 18,24,42,60, 64 months	GA	P: IP (TR)	Yes	Families recruited from WIC Nutritional Supplement offices, Hollingshead SES	↓ GA and ↓ SES associated with ↑ IP
Schultz et al. (2001)	MC	Longitudinal, N = 143, T1 M age = 4.9, T2 M age = 6.9	Language: Receptive, EF: SR	EK	Yes	Head Start enrollment	↑ Language and ↑SR associated w/ ↑EK
Fine et al. (2003)	MC	N = 154, Assessed at 7 and 11 years old	Language: Expressive	P: IP (SeR)	Yes	Head Start enrollment, INR	Neither language nor familial income contributed to IP
Erhart et al. (2019)	MC	N = 46, Mean age = 9	GA	EK	No	Household income; poverty duration: months lived with INR < 1.5	Neither poverty duration nor GA associated w/ EK, but poverty duration interacted with emotion intensity to negatively predict EK
Flouri et al. (2014)	MC	Longitudinal, N = 16916, Assessed at ages 3, 5, 7	Language Composite	P: IP (PR)	No	Household overcrowding, not owning the home, receipt of income support, and income poverty.	↓ SES and ↓ expressive language associated w/ ↑ IP. Language moderated the effect of SES on IP such ↓ SES children w/ ↑ language abilities had ↓ IP when compared to ↓ SES children w/ ↓ language abilities.
Flouri et al. (2015)	MC	Longitudinal, N = 16916, Ages 3, 5, 7	GA	P: IP (PR)	No	Household overcrowding, not owning the home, receipt of income support, and income poverty.	↓ SES, ↑ neighborhood deprivation, ↓ GA related to ↑ IP ↑ GA buffered against the effects of ↓ SES on IP
Bornstein et al. (2013) (Study 1)	MC, A	Longitudinal, N = 85, Mean age t1 = 4.52, T2 = 6.83	Language: Expressive, Receptive	P: IP (TR, PR)	No, oversampled for high SES	Hollingshead SES	↓ language ability associated w/ ↑ IP. SES not related
Bornstein et al. (2013) (Study 2)	MC, A	Longitudinal, N = 139, Mean age T1 = 4.05, 10.24, 13.83	Language: Expressive, Receptive	P: IP (TR, PR)	No, oversampled for high ses	Hollingshead SES	↓ language ability associated w/ ↑ IP. SES not related
Martin et al. (2007)	MC, A	Prospective Cohort Study, N = 689, followed cohort from birth - adulthood, but analyses focus on childhood and adolescent GAD	GA	P: GAD Diagnosis	No	PE & PO, family income	↓ GA, but not SES, related to ↓ childhood and adolescent-onset GAD

and ER (Elsayed et al., 2021). More specifically, the authors found that youth with lower INR had poorer parent-reported adaptive ER and greater parent-reported negative ER (i.e., emotional lability), and poorer receptive language abilities partially mediated both associations. Furthermore, the authors found that the mediation remained robust even after accounting for potential mediation by neural activity in regions of the brain which support top-down regulation during an ER of sadness fMRI task (Elsayed et al., 2021).

Internalizing psychopathology. In adolescence, only one study examined associations between SES, language and psychopathology, assessed via parent and child-report, and found that in a sample of 139 European-American youth who were over-represented families with higher SES, assessed at approximately ages four (M age = 4.05), 10 (M age = 10.24), and 13 (M age = 13.83), greater age four and age 10, but not age 14, general expressive and receptive language, assessed via standardized performance-based norm-referenced measures, was

associated with fewer prospective IP. Regarding SES, authors found that contributions of SES to IP were attenuated to non-significance when examined in combination with language and other factors such as maternal intelligence (Bornstein et al., 2013).

4.2. Results: contributions of EF and SES to emotional outcomes

4.2.1. Early childhood: contributions of EF and SES to emotional outcomes

EK. In total, four papers explored associations between SES, EF, and EK in early childhood, three of which were conducted with socioeconomically disadvantaged samples (Denham et al., 2012; Farrell and Gilpin, 2021; Nelson et al., 2011; Ursache et al., 2019). Two studies provide evidence for contributions of EF to concurrent EK independent of contributions of SES but suggested that contributions of early EF to prospective levels of EK may be moderated by SES (Denham et al., 2012; Ursache et al., 2019). One indicated that associations between EF and EK may be bidirectional and independent of income (Farrell and Gilpin, 2021), and one found no evidence that EF is associated with EK in a disadvantaged sample (Nelson et al., 2011) but did not examine contributions of SES explicitly.

ER. Only one study examined associations between SES, EF, and ER in early childhood and found no evidence of independent contributions of SES and EF to ER. In a group of 380 predominately SES youth (i.e., > 75% of sample with INR of less than two), neither children's performance on standardized performance-based assessments of EF nor INR at prekindergarten entry (M age = 52.50 months) were independently associated with teacher-rated assessments of a child's ER in the spring of prekindergarten. Rather, fall EF interacted with a fall language ability (see "Contributions of Language and Socioeconomic Status to Emotional Outcomes in Early Childhood") to predict ER; when a child entered preschool with low EF skills, their ER development over the year was dependent on their language skills, but for preschoolers with high EF, their development of ER was the same regardless of their language ability (Reilly and Downer, 2019).

Internalizing psychopathology. Four papers explored associations between SES, EF, and internalizing psychopathology in early childhood (Lengua et al., 2015, 2020; Rhoades et al., 2009; Wade et al., 2021). Three examined continuous distributions of SES; one indicated that composite EF is not independently associated with IP after considering SES (Wade et al., 2021), and the other two, which were from the same cohort, indicated that income is not associated with IP after accounting for composite EF (Lengua et al., 2015, 2020). All three of these studies explicitly examined and reported that associations between SES and IP were not mediated by EF (Lengua et al., 2015, 2020; Wade et al., 2021). The other study with a SES sample reported mixed contributions of EF to IP and reported that the EF contributions to IP are independent of SES (Rhoades et al., 2009).

4.2.2. Middle childhood: contributions of EF and SES to emotional outcomes

EK. Only two studies examined contributions of SES and EF to emotional outcomes, and both of these studies were conducted with samples of SES youth (Farrell and Gilpin, 2021; Schultz et al., 2001). One of these studies reported that better preschool SR assessed via teacher report was associated with better first-grade EK, and did not examine the contributions of SES (Schultz et al., 2001). The other study reported that first-grade IC and EK, assessed via standardized performance-based tasks, were not bi-directionally associated and income was not associated with EF or EK (Farrell and Gilpin, 2021).

ER and Internalizing Psychopathology. No studies met criteria.

4.2.3. Adolescence: Contributions of EF and SES to Emotional Outcomes

EK and ER. No studies met criteria.

Internalizing psychopathology. Only two papers examined contributions of SES and EF to emotional outcomes in adolescence (McNeilly et al., 2021; Vaughn-Coaxum et al., 2020). One of these

papers reported mixed evidence regarding contributions and mediations of EF and SES to IP (McNeilly et al., 2021), and one reported evidence that EF moderates associations between SES and IP (Vaughn-Coaxum et al., 2020).

4.3. Contributions of GA and SES to emotional outcomes

4.3.1. Early childhood: contributions of GA and SES to emotional outcomes

No studies met criteria.

4.3.2. Middle childhood: contributions of GA and SES to emotional outcomes

EK. A study by Erhart et al. (2019) examined how GA, degree of emotionality of emotional stimuli (i.e., intensity), and percentage of time since birth lived in poverty (i.e., poverty duration; months lived with INR < 1.5) are associated with accuracy on an EK task. In a group of 46 participants (M age = 9), authors reported that neither poverty duration nor GA or were independently associated with EK, but that poverty duration interacted with intensity to negatively affect EK. More specifically, children who lived in poverty for longer periods of time had poorer EK accuracy for equivalent increases in intensity when compared to youth not exposed to poverty (Erhart et al., 2019).

ER. No studies met criteria.

Internalizing psychopathology. Two of the three studies examining associations between SES, GA, and internalizing psychopathology in middle childhood indicated that lower SES and greater GA are independently associated with lower IP (Flouri et al., 2015; Owens et al., 1999). In contrast, one study found that when GA and SES are examined concurrently, SES does not contribute to an increased likelihood of a Generalized Anxiety Disorder (GAD) diagnosis, but lower GA is associated with an increased likelihood of a GAD diagnosis (Martin et al., 2007).

4.3.3. Adolescence: contributions of GA and SES to emotional outcomes

EK. No studies examined cognitive contributions of GA to EK in the context of SES in adolescence.

ER. In a study of 139 youth, GA in middle childhood was associated with both INR and adolescent parent-reported ER (M age = 16.39), but was not found to mediate associations between early-childhood INR and adolescent ER (Elsayed et al., 2021).

Internalizing psychopathology. In a study described in the middle childhood section (see: Contributions of GA and SES to Emotional Outcomes in Middle Childhood) greater age seven GA was associated with less likelihood of receiving a diagnosis of adolescent-onset GAD but SES was not independently or additively related to a GAD diagnosis in adolescence (Martin et al., 2007).

5. Discussion

5.1. Contributions of language and SES to EK, ER, and IP

Overall summary. The available literature indicates that in early and middle childhood better receptive and expressive language abilities are associated with better concurrent EK, with potential SES by language interactions predicting better prospective EK (Cutting and Dunn, 1999; Nelson et al., 2011; Schultz et al., 2001). For ER, the small literature provides some evidence for the independent importance of expressive language to ER in early childhood and for the potential mediating role of receptive language and SES to ER in adolescence (Elsayed et al., 2021; Reilly and Downer, 2019). For IP, the literature generally supported independent, and potential contributions via partial mediation, of poorer expressive language and SES to greater IP in early and middle childhood (Flouri et al., 2010, 2012, 2014; Tan and Dobbs-Oates, 2013) (Fig. 2).

Contributions of language and SES to EK. The available literature supports that SES, and poorer expressive and receptive language are

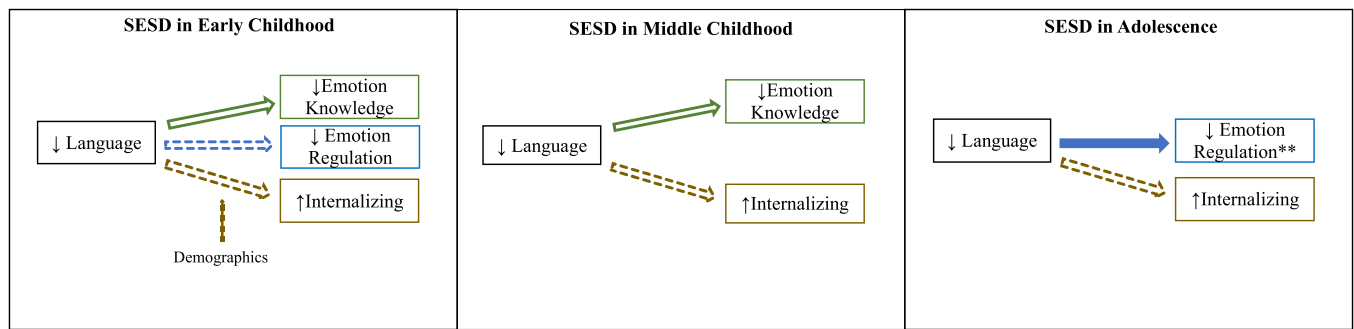


Fig. 2. Associations between SES, Language, and Emotional Outcomes. Solid lines indicate strong evidence in support of associations, dashed lines indicate inconclusive evidence. Filled arrows indicate mediation by language to emotion outcome. Absence of emotion construct indicates that no manuscripts examined this association. Arrow pointing to another arrow indicates moderation. **, associations between SES and ER in adolescence are equivocal.

independently associated with blunted EK in both early childhood and middle childhood. More specifically, the available evidence indicates that the reduced language abilities of SES youth may put them at risk of poorer EK above other negative contributions of SES (Cutting and Dunn, 1999; Nelson et al., 2011; Schultz et al., 2001). Importantly, the relative contributions of SES versus language to EK could not be determined from these manuscripts as two of these three studies were conducted in predominately disadvantaged populations (Nelson et al., 2011; Schultz et al., 2001). Specifically, only one study containing a sample across the SES spectrum explicitly assessed the independent role of SES to EK and reported that SES does not contribute to EK independent of language, but the authors did not examine mediation or moderation explicitly (Cutting and Dunn, 1999). Thus, the current literature does not allow for conclusions about whether associations between SES and EK are mediated or moderated by language abilities.

Contributions of language and SES to ER. The two reviewed manuscripts indicate that in early childhood SES does not contribute to poorer ER independent of expressive and receptive language abilities (M. Li et al., 2017; Reilly and Downer, 2019). In adolescence, the reviewed paper indicated that language may mediate associations from SES to ER and also serve as independent contributor to ER (Elsayed et al., 2021). The limited number of available manuscripts and methodological differences between studies limits the vigor of these conclusions. Overall, it remains largely unclear whether associations between SES, language and ER are mechanistic (i.e., associations between SES and ER are mediated by language), or interactive (i.e., SES moderates the contributions of language to ER) or independent in nature (i.e., SES and language contribute via separate pathways to ER). These findings highlight the necessity of careful attention to distinct facets of language and indicators of SES when delineating associations with ER.

In early childhood, the two papers evaluating the contributions of language and SES to ER indicated that language and SES do not independently contribute to poorer early childhood ER (M. Li et al., 2017; Reilly and Downer, 2019) with neither finding SES associations and only one finding language associations (Reilly and Downer, 2019). This conclusion must be considered in light of the following limitations: Li et al. results (2017) regarding SES' null contribution to ER may reflect shared variance between SES and assessed related covariates, such as household instability, that likely masked some of the independent contributions of SES due to multicollinearity (Beckstead, 2012). Secondly, null results regarding INR from Reilly and Downer (2019) may reflect the restriction of INR range in the study which contained only socioeconomically disadvantaged youth, making interpreting the null contributions of SES difficult (Weber, 2001).

Numerous methodological differences between the two studies likely account for reported discrepancies regarding the role of language in ER. Li et al. (2017) only assessed receptive language, whereas Reilly and Downer assessed both receptive and expressive language (M. Li et al., 2017; Reilly and Downer, 2019). Aforementioned differences regarding

the contributions of language therefore may reflect specific contributions of expressive language to ER during early childhood which has been underscored in previous literature (Cole et al., 2010). Moreover, Reilly and Downer (2019) assessed ER using teacher-report of adaptive ER and negative lability (i.e., dysregulation) throughout the academic year, whereas Li (2017) assessed ER in response to real-time disappointment and unfairness during frustrating tasks (M. Li et al., 2017; Reilly and Downer, 2019). It is possible that the contribution of language to "in the moment" ER in response to novel stimuli (M. Li et al., 2017) is different than the contribution of language to long-term ER in response to more expected challenges, such as those seen throughout the year by classroom teachers (Reilly and Downer, 2019).

In adolescence, the reviewed manuscript indicated that poorer early receptive language ability partially mediated between lower INR and poorer parent-reported ER (Elsayed et al., 2021). In contrast to the findings in early childhood, which suggested that expressive language ability may be particularly important to ER, these results may support the importance of receptive language to the ER demands of adolescence, and may signal that receptive language contributes to the more cognitively complex forms of ER (e.g., cognitive reappraisal) that are used during adolescence (K. L. Bell and Calkins, 2000; Bendezú et al., 2018). Importantly, this study did not include measures of expressive language. These results may reflect that the role of language may change in accordance with changes in the challenges and demands of these two developmental periods.

Contributions of language and SES to IP. Across all developmental epochs, the nascent literature supported that lower expressive language contributes to greater IP independent of associations between SES and IP. The literature is equivocal regarding contributions of receptive language to IP independent of SES and signaled that contributions of receptive language to IP may be moderated by demographic factors. The available literature does not allow for conclusions regarding whether associations between SES, language and IR may additionally be mechanistic or interactive.

In early childhood, poorer expressive language is associated with greater parent-reported IP independent of SES (Flouri et al., 2010, 2012, 2014; Tan and Dobbs-Oates, 2013). The contribution of receptive language to IP in early childhood is more equivocal, potentially reflecting the many related covariates (e.g., maternal responsiveness, sibling negativity) assessed in the available study (Wade et al., 2021). Among a predominately SES sample, there is evidence that poorer receptive language is associated with greater teacher-reported IP (Rhoades et al., 2009), but these effects may be moderated by age and sex (Tan and Dobbs-Oates, 2013).

In middle childhood, one well-powered study supported that early expressive language, contributed independently and prospectively to IP at age seven (Flouri et al., 2014). This study also reported that SES moderated associations between expressive language and IP such that greater language buffers against the deleterious impacts of lower SES

resulting in fewer IP, and that within-individual change in language ability did not predict IP in high SES youth to the same extent as it did in SESD youth (Flouri et al., 2014). Two smaller studies, one in a sample of mostly higher income youth, and one in mostly low income youth, both reported that SES does not contribute to internalizing in youth after considering expressive and receptive language (Bornstein et al., 2013; Fine et al., 2003). The lack of SES contributions reported in these two papers are difficult to interpret given restriction of range of SES, which may artificially reduce the magnitude of the SES to IP relationship (Weber, 2001). Moreover, in the SESD sample, expressive language did not contribute to IP (Fine et al., 2003), and in the predominately socioeconomically advantaged sample, expressive and receptive skills did contribute to IP (Bornstein et al., 2013; Fine et al., 2003). These differences may reflect the added benefit of receptive language to IP, and may reflect that contributions of language to IP are sensitive to age within developmental epoch; the study which found contributions of language was conducted in early middle childhood (Bornstein et al., 2013) while the other was conducted toward the end of middle childhood (Fine et al., 2003). One study conducted with an adolescent sample overrepresented for high SES reported that better expressive and receptive language are prospectively and concurrently associated with fewer IP in adolescence, and that SES is not associated with IP if considered simultaneously with language (Bornstein et al., 2013; Fine et al., 2003).

Together, these results are partially consistent with findings from a recent metaanalysis that reported that language abilities and internalizing psychopathology are associated, and that SESD does not moderate this association (Hentges et al., 2021). The metaanalysis, however, did not assess contributions of domains of language (e.g., expressive versus receptive language). Findings from this review indicated that across development, expressive language may be particularly important to IP independent of SES, and although the available evidence is not conclusive, it points to the possibility that expressive language may partially mediate associations between SESD and IP.

5.2. Contributions of EF and SES to EK, ER, and IP

Overall summary. For EF, the reviewed literature indicated that better EF is associated with greater concurrent EK independent of SES, but that IC may be especially important for EK development in early childhood for SESD youth and SR is especially important for EK in middle childhood for SESD youth (Farrell and Gilpin, 2021; Schultz et al., 2001; Ursache et al., 2019). For ER, the reviewed literature indicated that in early childhood, EF alone does not independently contribute to ER but may contribute to ER in combination with language (Reilly and Downer, 2019). For IP, results indicated that in early childhood, EF and SES contribute largely overlapping and non-independent variance to IP (Lengua et al., 2015, 2020; Rhoades et al., 2009; Wade et al., 2021) and evidence regarding mediation in inconclusive. In contrast, results in adolescence suggested that EF may mediate or moderate associations between SES and IP but that these

medications are specific to metrics of EF and SES (McNeilly et al., 2021; Vaughn-Coaxum et al., 2020) (Fig. 3).

Contributions of EF and SES to EK. The available literature indicates that greater early and middle childhood EF is associated with better EK independent of SES, and there was inconsistent evidence as to whether early EF interacts with (i.e., moderates) SES to provide prospective benefit to later EK for SESD youth (Denham et al., 2012; Farrell and Gilpin, 2021; Ursache et al., 2019). The available literature does not allow for conclusions regarding mediation by EF to EK from SESD. These conclusions should be considered in tandem with the vast methodological differences in the reviewed studies. With this limitation in mind, inconsistent findings regarding interactions between EF and SES may reflect: (1) that only certain facets of EF interact with SESD to predict later EK benefits (Denham et al., 2012; Schultz et al., 2001; Ursache et al., 2019), (2) that restriction in socioeconomic range in the reviewed literature masks potential SES and EF interactions (Nelson et al., 2011; Ursache et al., 2019), (3) that developmental epoch interacts with SES and EF in its association with EK (Denham et al., 2012; Farrell and Gilpin, 2021; Ursache et al., 2019).

Four of the five reviewed studies support that better EF is associated with greater concurrent EK, independent of SES (Denham et al., 2012; Farrell and Gilpin, 2021; Schultz et al., 2001; Ursache et al., 2019). Inconsistent findings regarding prospective relationships of EF to EK may reflect attenuated SES effects due to the restriction of socioeconomic range in some of the studies (Weber, 2001). Importantly, differences between these studies likely also reflect the relative importance of different facets of EF to EK. Ursache et al. (2019) assessed SR and Farrell and Gilpin (2021) assessed IC, suggesting that IC may be particularly important in the prediction of early-childhood EK (Farrell and Gilpin, 2021; Ursache et al., 2019). Similarly, Schulz assessed SR and Farrell assessed IC, suggesting that by middle childhood this relationship flips, and SR may be more important than IC (Farrell and Gilpin, 2021; Schultz et al., 2001). One manuscript reported that among SESD youth having high versus low WM ability did not distinguish youth with regard to EK ability (Nelson et al., 2011). These results are seemingly contradictory to the conclusions above, but may reflect that the constructs of EF assessed in other studies were generally broader than WM, which tends to have lower convergent validity with other indicators of EF (Bailey et al., 2018). These results are also likely less sensitive to relationships between EF and WM given that WM and EK were defined categorically as either high or low, whereas other papers examined these relationships more continuously.

All together, these results indicated that better EF is associated with greater concurrent EK independent of SES, and that domains of EF are differentially predictive of later EK at different points over the course of development, and that this may be moderated by SES. Specifically, IC may be especially important for EK development in early childhood for SESD youth, and SR especially important for EK in middle childhood for SESD youth (Farrell and Gilpin, 2021; Schultz et al., 2001; Ursache et al., 2019).

Contributions of EF and SES to ER. Only one study examined

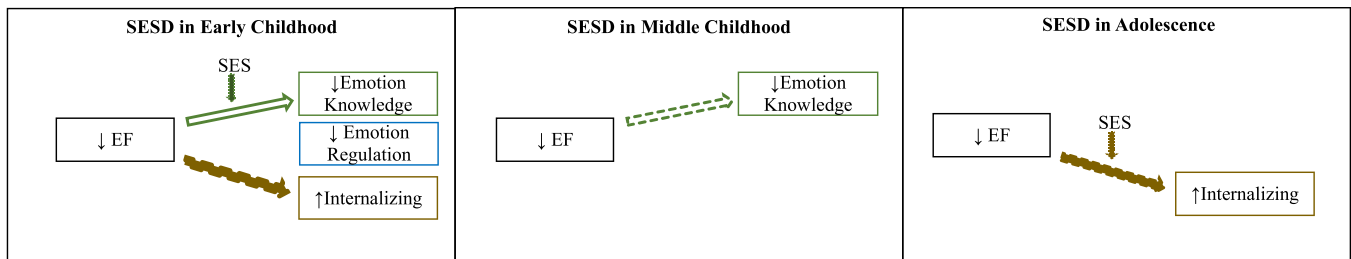


Fig. 3. Associations between SES, EF, and Emotional Outcomes. EF, Executive Function. Solid lines indicate strong evidence in support of associations, dashed lines indicate inconclusive evidence. Filled arrows indicate mediation by language to emotion outcome. Absence of emotion construct indicates that no manuscripts examined this association. Arrow pointing to another arrow indicates moderation.

associations between EF, SES, and ER and indicated that early childhood EF interacts with language to contribute to ER, but INR does contribute to ER (Reilly and Downer, 2019). Given that this sample was all SESD, the null INR result may reflect attenuated SES effects due to the restriction of range (Weber, 2001).

Contributions of EF and SES to IP. In early childhood, there is inconclusive evidence regarding mediation by EF from SESD and IP with the overall evidence suggesting that EF and SESD contribute largely overlapping variance to IP (Lengua et al., 2015, 2020; Rhoades et al., 2009; Wade et al., 2021). In adolescence, there is some evidence supporting potential mediation or moderation by SESD from EF to IP that differ across EF, SES, and IP domain (McNeilly et al., 2021; Vaughn-Coaxum et al., 2020).

Studies in the adolescent period more narrowly operationalized EF and indicated that relationships between EF, SES, and IP depend on how SES is operationalized and may be different across EF domains. Mixed evidence regarding mediation emerged (McNeilly et al., 2021); parent-reported composite EF was found to mediate associations between income-to-needs and parent education to IP in only one of the two studies (McNeilly et al., 2021). It is noteworthy that evidence supporting mediation was found only when continuous measures of SES were examined (i.e., income to needs, parent education) but not when more categorical measures of SES were examined. This may reflect statistical challenges in modeling relationships between one categorical variable (e.g., living below the poverty line) and two continuous variables (i.e., EF, internalizing psychopathology) (Iacobucci, 2012), but may also reflect that income to needs and parent-education are more strongly related to psychopathology than other metrics of SES (Peverill et al., 2021). Moreover results that parent-reported composite EF mediate associations to parent-reported psychopathology may reflect shared method variance) (Ten Eycke and Dewey, 2016). The remaining study during the adolescent period indicated that although SES and EF do not independently contribute to depression symptoms, SES and IC interact to predict depression symptoms such that greater economic resources were associated with lower depression only in the context of higher IC scores (Vaughn-Coaxum et al., 2020). As only one study assessed moderation, conclusions about whether IC is the only facet of EF that has an interactive relationship with SES, whether this relationship is specific to depression symptoms, or whether other facets of EF may also interact with SES to predict more broad internalizing psychopathology cannot be made. Taken together, findings from the adolescent period highlight that mechanistic or interactive associations between SESD and EF to IP likely differ depending on the operationalization of SES, IP, and the construct of EF (McNeilly et al., 2021).

5.3. Contributions of GA and SES to EK, ER, and IP

Overall summary. For GA, results in middle childhood indicated that GA does not independently contribute to EK but that SES may

interact with other factors to predict EK (Erhart et al., 2019). In adolescence, GA contributed to ER but did not mediate associations between INR and ER (Elsayed et al., 2021). For IP, in middle childhood, there is evidence that GA and SES independently contribute to IP (Flouri et al., 2015; Owens et al., 1999) and that GA and SES may interact in association with IP. In middle childhood and adolescence, GA, but not SES, are associated with a diagnosis of GAD (Martin et al., 2007) (Fig. 4).

Contributions of GA and SES to EK. Only one study examined contributions of GA and SES to EK, and thus no conclusions regarding mediation or moderation can be made. The available study suggested that neither SESD nor GA independently contribute to middle childhood EK, but that SESD may negatively interact with other predictors of EK (Erhart et al., 2019). This finding is contradictory to previous literature which highlights GA as being related to greater EK above the contributions of language (Albanese et al., 2010; Bennett et al., 2005; De Stasio et al., 2014); this may reflect methodological differences in EK assessment.

Contributions of GA and SES to ER. One study examined associations between GA and SES with ER and found that GA did not mediate associations between early INR and ER in adolescents (Elsayed et al., 2021). This null finding may indicate that GA is relatively less important during development to ER than during adulthood, or that GA predicts ER strategy use but not general tendency toward adaptive ER.

Contributions of GA and SES to IP. Two separate studies in early childhood indicated that lower GA and SES are independently associated with more IP in early childhood (Flouri et al., 2015; Owens et al., 1999). Both of these studies examined interactions between SES and GA, but only one found evidence that higher GA buffered against the effects of lower SES on IP (Flouri et al., 2015). These differences likely reflect that one study contained predominately SESD youth as restriction of SES range may have masked potential interactive effects between SES and GA (Weber, 2001). Moreover, differences between these two studies likely also reflects differences in sample size such that null results may reflect underpowered analyses.

In middle childhood and adolescence one study found that only GA, but not SES, contributed to the likelihood of GAD diagnosis in childhood or adolescence (Martin et al., 2007). This finding may reflect the low endorsement of GAD diagnosis in this sample, and that SES was categorized as low, medium, and high in this study rather than continuously; the low GAD endorsement and examining SES as categorical rather than continuous likely reduced the statistical power to find effects of SES (J. Cohen, 1992). Discrepancies between the early childhood results relative to the middle childhood and adolescent results may reflect that GA is more important to GAD than SES specifically (Coplan et al., 2012), and may also reflect that experiencing SESD confers more risk to sub-threshold IP but not necessarily full disorders.

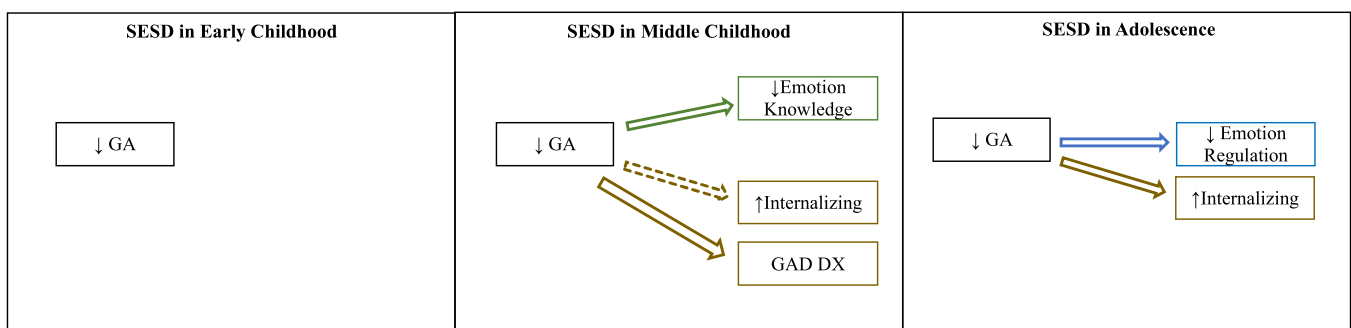


Fig. 4. Associations between SES, GA, and Emotional Outcomes. GA, General Ability. Solid lines indicate strong evidence in support of associations, dashed lines indicate inconclusive evidence. Filled arrows indicate mediation by language to emotion outcome. Absence of emotion construct indicates that no manuscripts examined this association. **, associations between SESD and ER in adolescence are equivocal.

5.4. Limitations

Limitations include that the current review did not assess study quality due to the limited number of studies available and inter-rater reliability was not established given the presence of only one manuscript reviewer (NME). Another major limitation is the selective operationalization of emotion processes and cognitive processes. This was done to highlight the most studied domains but likely limited the generalizability of this review's results. Moreover, there was little consistency between studies in the operationalization of SES, emotion, and cognitive processes, thus limiting the specificity of conclusions.

5.5. Future directions

The findings of this review highlight the need for future research to outline associations between domains of cognitive processes, SESD, and emotion within the context of development. In general, there is a paucity of data that examines the relative contributions of cognitive domains beyond broad categories, limiting conclusions about the relative contributions of domains of cognition to emotional outcomes. Moreover, although some of the work reviewed took a longitudinal approach, studies rarely assessed more than one developmental epoch (i.e., early childhood vs. middle childhood) or assessed the importance of within-individual change in cognition, thus limiting the ability to make conclusions about how within-or-between individual differences in cognition contribute to emotion as expectations regarding emotion change per developmental norms. This review highlights the dearth of literature in middle childhood specifically, and the dearth of literature that examines the role of neural function and structure in the relationship between cognition and emotion.

Future research that takes a developmentally sensitive perspective and assesses SES, multiple domains of cognitive function and emotion, as well as neural structure and function, will allow for a better understanding of the integration of cognition-emotion both behaviorally and neurally. Future research should contain participants across the socio-economic spectrum and should include assessments of language, EF, and GA that are performance based and norm standardized. Measures of EK, ER and internalizing psychopathology should be methodologically triangulated and assess multiple facets of these construct given the complex nature of each of these constructs, and developmental shifts in functioning expectations across development. These sort of study designs will allow for a better understanding of both the independent contributions of SESD and cognition to emotion and the complex mediational and moderational patterns that may exist both concurrently and prospectively. Moreover, this sort of research can examine bidirectional contributions of cognition and emotion to one another. This understanding may inform understanding of how early exposure to adverse experiences, like SESD, alters the nature of cognition-emotion relationships across development but may also improve identification of, and intervention with, youth at risk for emotional disturbances.

6. Conclusions

This review synthesized literature on the associations between cognition and emotion within the context of development and SESD. Findings indicated that the relative contributions of SES and cognition to emotion, and that the nature of association between cognitive and emotion, are highly dependent on developmental epoch, and domain of cognition assessed. Specifically, this review suggests that in early and middle childhood both language and executive function may independently contribute to EK in youth above contributions of SESD, and that EF may also interact with SES to predict future EK. Given the dynamic interplay between EK and other emotional processes, these findings highlight the need for continued delineation of the roles of SES to EK via cognitive processes and indicates that interventions which target early cognitive skills may benefit downstream emotion processes

(Southam-Gerow and Kendall, 2002). Findings regarding potential interactions between SESD and cognition in prospectively predicting later EK also highlight early cognitive alterations as prospective risk factors for poor emotional outcomes (Denham et al., 2012; Farrell and Gilpin, 2021). This review also found that language and SES independently contribute to ER, and that in adolescence there may be mediation by language. This suggests that one pathway by which SESD youth may be at higher risk for poor developmental outcomes, such as poorer ER, is through poor language, and thus implicates language as a target for interventions that may improve psychological outcomes in youth (Elsayed et al., 2021). This link is underscored by findings that across development language contributes to greater IP. Most of the literature in this review did not include analyses that examined mediation or moderation by cognitive outcomes. There are hints that cognition may be a mechanism altering emotion functioning in the context of SESD. Moreover, findings that language and EF may interact to predict ER in SESD youth also suggests that within the context of SESD there may be differential risk profiles associated with emotion outcomes depending on youth's specific cognitive profiles. Altogether, these broad conclusions indicate that future longitudinal and developmentally sensitive research is needed to unpack cognition emotion interactions within the context of SESD.

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