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Review

The developmental origins of ruminative response style: An integrative review

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HIGHLIGHTS

- This review examines the developmental risk factors of ruminative response style.
- A model integrating these factors within a conceptual framework is proposed.
- Risk factors for distress lead to engagement in rumination.
- When rumination is well-practiced, it will consolidate into a trait-like response style.
- This is especially true among adolescents who experience cognitive control deficits.

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ABSTRACT

Rumination has been conceptualized as a stable, trait-level response style involving repetitive and passive focus on the symptoms of distress and the possible causes and consequences of those symptoms. This theoretical review examines developmental risk factors of ruminative response style, incorporating a developmental psychopathology perspective. A model integrating these developmental factors within a conceptual framework is proposed, wherein risk factors for distress (i.e., temperamental negative affectivity, stressful environments, parenting, and genetic vulnerability) lead to engagement in rumination. We propose that when rumination is well-practiced, it will consolidate into a trait-like response style, especially among adolescents who experience cognitive control deficits. Reciprocal relationships and moderators that may contribute to the formation of a ruminative response style are also included. To understand how these factors converge and influence the formation of ruminative response styles, we review patterns of stability and change in physical and cognitive development to demonstrate that individual differences in rumination may emerge and consolidate into enduring, trait-level response styles during early adolescence.

Rumination refers to a mode of responding to distress that involves repetitively and passively focusing on the symptoms of distress and the possible causes and consequences of those symptoms (Nolen-Hoeksema, 1991). According to the response styles theory, rumination maintains and exacerbates negative mood, triggering and prolonging depressive episodes via several mechanisms. These include enhancing negative thinking, impairing problem solving, interfering with instrumental behavior, and eroding social support (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). The original response style theory focused on the relationship between rumination and depression, but subsequent studies have established rumination as a transdiagnostic cognitive vulnerability factor that predicts a number of outcomes (e.g., anxiety, binge eating, alcohol misuse) in children and adolescents (for a meta-

analysis, see Aldao, Nolen-Hoeksema, & Schweizer, 2010).

The content of ruminative thought is typically negative in valence, and rumination is associated with other maladaptive cognitive styles (Nolen-Hoeksema et al., 2008). However, rumination is not defined by the content of thought but rather its repetitive and passive nature (Nolen-Hoeksema, 1991). While it possible to engage in rumination at any given moment (i.e., state rumination), a ruminative response style has been conceptualized as a stable mental habit or trait wherein people consistently use passive, negative, and abstract repetitive thoughts to cope with discrepancies between desired states and present reality, pairing negative mood and repetitive thinking over time (Watkins & Nolen-Hoeksema, 2014).

To date, there are no comprehensive reviews on the developmental

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origins of ruminative response style or its emergence and stabilization in children and adolescents. We aim to address this gap by reviewing the developmental risk factors of rumination, incorporating a developmental psychopathology perspective to examine the possible vulnerability factors that contribute to the tendency to ruminate. We suggest there are several risk factors (e.g., temperamental negative affectivity, stressful environments, parenting, and genetics) that contribute to negative affect, which is the primary proximal risk for spontaneous or momentary rumination. When a ruminative self-focus is rehearsed in response to negative affect, it has the potential to automatically cue ruminative thought, such that it consolidates into a more trait-like response. Youth who are unable to flexibly control cognitive processes, such as effectively discard contents of working memory and control attentional resources, are more likely to ruminate, thus consolidating ruminative tendencies into a habitual way of responding to distress. We propose that difficulties with cognitive control likely emerge early in life through temperamental effortful control differences, but suggest that the consolidation of a ruminative response style occurs later in development due to processes including cognitive development and brain maturation.

A conceptual model is proposed in Fig. 1 that integrates these factors along with other factors that appear to play a role in the development of a ruminative response style (i.e., gender and psychopathology). It is important to highlight the recursive nature of this model, as we suggest that once a ruminative style consolidates, individuals are more likely to ruminate in response to distress. This is important conceptually, as it suggests that as ruminative style increases, state rumination increases in response to negative affect, thereby increasing rehearsal effects and leading to more consolidation of this trait-like response. We also include in our model that a ruminative style predicts psychopathological outcomes that maintain and exacerbate negative affect, further contributing to this iterative process. This article builds on reviews examining the nature and consequences of rumination (Lyubomirsky, Layous, Chancellor, & Nelson, 2015; Nolen-Hoeksema et al., 2008), as well as the developmental origins of related cognitive vulnerabilities (Hankin et al., 2009). The model presented here was developed following a comprehensive review of all relevant studies; we incorporated risk factors with the most consistent guidance from available research literature.

Moreover, to understand how these developmental risk factors converge and influence the formation of ruminative response styles, we review patterns of stability and change demonstrating that individual differences in rumination may emerge and consolidate into enduring,

trait-level response styles during early adolescence. We incorporate research in cognitive and physical development (i.e., brain maturation and pubertal timing) to explain mechanisms underlying these processes. First, however, we briefly review similarities and differences in theoretical conceptualizations of different classes of repetitive thought, and consider methodological issues in the measurement of rumination in younger samples.

1. The conceptualization and measurement of rumination

The process of thinking attentively, repetitively, or frequently about oneself and one's world forms the core of a number of different classes of repetitive thought. Of them, worry and rumination have received the most empirical attention. These constructs share a repetitive, perseverate self-focus, and abstract, over-general thinking style. Although there is evidence for intercorrelations between worry and rumination, key features differentiate them, including time orientation, focus, and conscious and nonconscious functions (Nolen-Hoeksema et al., 2008). We focus on rumination in this review; high-quality reviews examining the development of worry are available elsewhere (Kertz & Woodruff-Borden, 2011; Rapee, 2001; Vasey & Dadds, 2001).

To identify rumination early in life, the Children's Response Styles Questionnaire (CRSQ; Abela, Brozina, & Haigh, 2002) has become one of the most widely adopted measures to assess children's tendency to ruminate. This questionnaire, modeled after the Response Styles Questionnaire (RSQ) developed for older adolescents and adults (Nolen-Hoeksema & Morrow, 1991), is a self-report scale describing styles of responding to sad feelings that are self-focused (e.g., *When I'm sad, I think about how alone I feel*). The instrument has evinced good psychometric properties (e.g., Abela, Vanderbilt, & Rochon, 2004). However, a major limitation of the CRSQ (and similar measures) is its reliance on introspective abilities to self-report on the frequency and content of mental processes. This is particularly relevant for younger samples, as children often have limited awareness of their cognitive states, abilities, and operations (Flavell, 1999). Emerging research has begun to identify alternative methods for response style assessment in children (Baiooco et al., 2017; Davis, Levine, Lench, & Quas, 2010).

Another limitation of the CRSQ is it comprises a single rumination factor, while the RSQ has both a brooding factor (the more maladaptive aspect of rumination, consistently associated with depression) and a reflection factor (a more benign form of self-focus that actively examines one's emotions) (see Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Of note, Burwell and Shirk (2007) modified the Ruminative

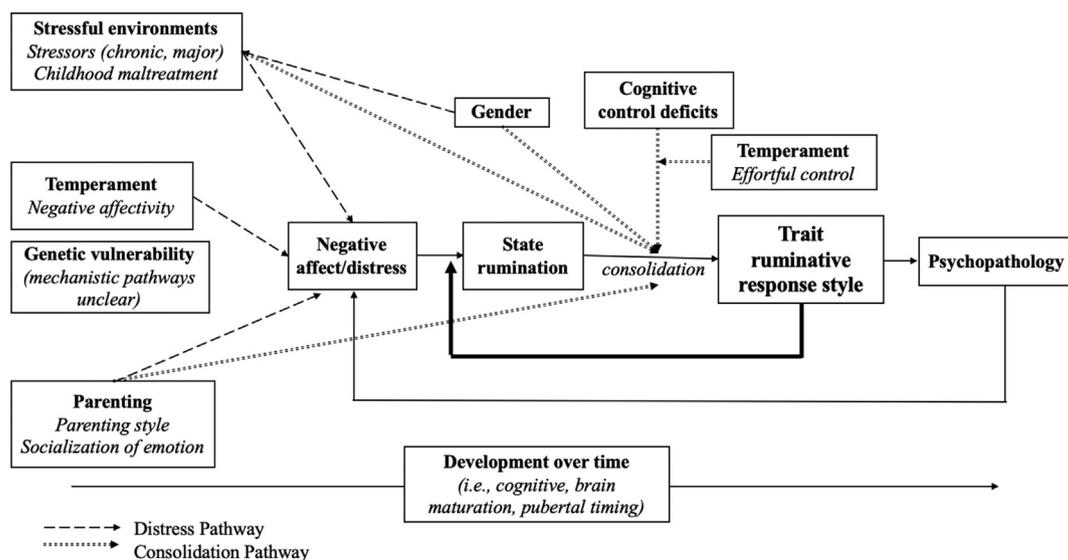


Fig. 1. A conceptual model integrating the developmental risk factors of ruminative response style.

Response Scale, a related measure, for use with adolescents by slightly modifying the instructions and anchoring the items to recent stressful events. The authors found a brooding and reflection factor, though the items do not completely overlap with *Treynor et al.*' (2003) subscales. This suggests that what has been labeled as *rumination* likely involves both adaptive and maladaptive self-focus in adolescents and adults, although much of the research on the development of ruminative responses does not utilize this measure nor focus on this distinction. Overall, our review of existing studies relies primarily on self-report measures of a single rumination factor, and should be considered with this limitation in mind.

Because most research conducted to date has relied on measuring rumination with a self-report questionnaire on one's general tendency to ruminate, direct support for the pathways leading to engagement in rumination as well as the transition from occasional rumination to a habitual ruminative response style is understudied. One study found that it is quite normative for young adolescents to respond to a stressor by engaging in negative self-referential thoughts (i.e., state rumination, measured by coding thought samples), but some adolescents seem unable to disengage from this process (*Hilt & Pollak, 2013*). We theorize that repeated engagement in rumination along with deficits in cognitive control might explain the transition from more occasional rumination to a more trait-like ruminative response style. In support of this, cross-sectional and longitudinal studies have found that older adolescents report more habitual rumination compared to younger adolescents and children (*Hankin, 2008; Heleniak, Jenness, Stoep, McCauley, & McLaughlin, 2016; Jose & Brown, 2008*). Research on cognitive development and brain maturation provide an important back-drop to consider why rumination may become a more consolidated habit during this time in development.

2. Developmental factors associated with rumination

Our model (*Fig. 1*, described above) posits two pathways through which risk factors influence the consolidation of a ruminative response style. First, the risk factor may increase the experience of negative affect. This supplies the individual with depressogenic content on which to dwell and increases the likelihood of spontaneous (state) rumination, which when rehearsed will consolidate into trait rumination (the 'Distress' Pathway). Second, the risk factor may increase the likelihood that this consolidation process (from state to trait rumination) will occur (the 'Consolidation' Pathway). Below we discuss major developmental factors from existing literature, reviewing available evidence and commenting on the relevance to these pathways.

2.1. Temperament

Temperament is conceptualized as multidimensional individual differences in emotional reactivity and self-regulation that are present from infancy and stable over time (*Rothbart & Bates, 1998*). Negative affectivity (NA) is a temperamental constellation characterized by a tendency for high frequency of negative emotionality, heightened sensitivity to negative stimuli, and elevated intensity of negative emotional reactions. NA is associated with increased attention to negative events, self-focus, catastrophizing, and difficulty implementing adaptive emotion regulation strategies (e.g., *Pyszczynski, Holt, & Greenberg, 1987; Watson & Clark, 1984*). As such, affectively vulnerable youth may attend perseveratively to negative events and experience heightened negative affect, leading to increased rumination (*Hyde, Mezulis, & Abramson, 2008*).

Our model proposes affective vulnerability confers risk for rumination through negative affect. Once negative emotions are elicited, these individuals are more likely to perseveratively direct attention to negative affect through engagement in spontaneous rumination (i.e., Distress Pathway). In support, *Mezulis and Rudolph (2012)* used stressor-specific assessments and a daily diary design to examine the

proximal effects of NA on state rumination in adolescents; they demonstrated that NA predicts greater weekly, event-specific rumination about daily stressors. This effect was significant after controlling for trait rumination, suggesting NA impacts event-specific rumination above and beyond the trait tendency to ruminate. This evidence suggests that when youth prone to negative affect encounter daily stressors, their affective responses (i.e., increased distress and reactivity) may elicit greater attentional focus on the stressor, spurring rumination.

We hypothesize that, over time, some youth high in NA will rehearse this pattern of perseverative processing, so that it may consolidate into a more habitual ruminative style. Studies have linked NA to ruminative response tendencies, indicating concurrent associations between NA and trait rumination in adolescents (*Muris, Fokke, & Kwik, 2009; Verstraeten, Bijttebier, Vasey, & Raes, 2011; Verstraeten, Vasey, Raes, & Bijttebier, 2009*). Prospective research also demonstrates greater NA in infancy predicts increased rumination in early adolescence (*Mezulis, Priess, & Hyde, 2011; Mezulis, Simonson, McCauley, & Vander Stoep, 2011*). This suggests individuals high in NA experience more intense and chronic affective responses that may predispose them towards rumination, and that over time this may consolidate into a ruminative style. Moreover, these studies demonstrate trait rumination mediates the relationship between NA and depressive symptoms, suggesting high-NA youth are more likely to ruminate, which then predicts increases in psychopathological symptoms.

2.2. Stressful environments

Another factor that may increase engagement in rumination is the experience of stress. Conceptual models regarding the etiology of rumination suggest the experience of stressful events creates goal discrepancies between desired states and present realities (*Carver & Scheier, 1981; Martin & Tesser, 1996*). These discrepancies elicit negative cognitive content and increase the experience of negative affect that, in turn, leads to engagement in rumination in an attempt to reduce such discrepancies and regulate associated distress (i.e., Distress Pathway). Since rumination typically impedes one's ability to engage in problem solving or active coping (*Nolen-Hoeksema et al., 2008*), it exacerbates negative thoughts and feelings that can contribute to prolonged periods of distress well after the stressful event (*Lyubomirsky & Tkach, 2004*). Uncontrollable or chronic stressors may be more likely to induce rumination because the discrepancies they create are often difficult to resolve (*Watkins, 2008*).

Several studies have found that stressful life events are associated with rumination in children and adolescents (*Waasdorp, Bagdi, & Bradshaw, 2010; Young, LaMontagne, Dietrich, & Wells, 2012*). Evidence from experience-sampling studies also suggests a relation between daily stressful events and momentary ruminative self-focus. Patterns of results indicate on days when stressors are experienced, engagement in spontaneous rumination is higher (*Hatzenbuehler, Nolen-Hoeksema, & Dovidio, 2009; Moberly & Watkins, 2008*). In these studies, spontaneous rumination also mediates the prospective relationship between negative events and subsequent negative affect. This suggests negative events induce rumination that, in turn, prolong distress after the event occurs by keeping the stressor "alive," and the individual activated (*Brosschot, Gerin, & Thayer, 2006*). To date studies using experience-sampling methods have only been conducted in adults; it will be important for future studies to examine these relations in youth.

Over time, our model suggests individuals who experience repeated stressors and engage in rumination to cope will likely begin to pair stressor-induced negative affect with state episodes of ruminative thought, such that a negative mood state may become an automatic cue for rumination. This increases the potential for ruminative self-focus to be consolidated into a more trait-like response style (*Watkins & Nolen-Hoeksema, 2014*). Indeed, in longitudinal studies, stressful life events

predict subsequent increases in the use of maladaptive coping strategies, including rumination, which in turn confer risk for psychopathology. In one of the few prospective studies to examine relations between stress and rumination, Michl, McLaughlin, Shepherd, and Nolen-Hoeksema (2013) followed samples of adolescents and adults. In both, exposure to stressful events predicted subsequent increases in rumination, indicating stressors may be linked to changes in rumination that are maintained for prolonged periods of time.

The measures of rumination used by Michl et al. (2013) assessed the degree to which individuals respond to dysphoric feelings with trait rumination, rather than measuring engagement in rumination in response to a specific stressor. This trait-level measure suggests stressful events may lead to lasting changes in responses to distress that generalize to many areas of an individual's life, thereby increasing the likelihood ruminative tendencies are consolidated into a habitual style. This is consistent with a study of bereaved adults indicating those with greater stress burden (i.e., experiencing more stressors in addition to bereavement) showed increased rumination over time (Nolen-Hoeksema, Parker, & Larson, 1994). Moreover, in an experience-sampling study, trait rumination moderated the link between stressors and negative affect, as high trait ruminators reported more negative affect after negative events than low trait ruminators (Genet & Siemer, 2012; Moberly & Watkins, 2008). This suggests individuals more likely to engage in rumination show greater reactivity to stress, perpetuating this iterative cycle.

We suggest adolescence is a critical developmental period to understand the impact of stress on rumination. It is well-established that in adolescence stress exposure increases, and stressful events are more closely linked to greater amounts negative affect (e.g., Larson & Ham, 1992). Increased emotional vulnerability to stress suggests adaptive regulation is crucial but may be more difficult to employ given the heightened arousal and negative affect linked to stressors, increasing the risk of responding to distress with maladaptive strategies like rumination. In addition to Michl et al. (2013), further studies with adolescents demonstrate prospective links between stressful life events, including peer victimization and community violence, and rumination (Heleniak, King, Monahan, & McLaughlin, 2018; Mathieson, Klimes-Dougan, & Crick, 2014; McLaughlin & Hatzenbuehler, 2009; McLaughlin, Hatzenbuehler, & Hilt, 2009; Padilla Paredes & Calvete, 2014). Interestingly, studies examining gender as a moderator show no gender differences in the relation between stressful events and rumination (Felton, Cole, & Martin, 2013; Mathieson et al., 2014; McLaughlin et al., 2009; McLaughlin & Hatzenbuehler, 2009; Michl et al., 2013). Although females and males may be equally likely to ruminate after stressors, research suggests females are more likely to experience uncontrollable interpersonal stressors (i.e., sexual abuse, harassment, role burden) that may lead to engagement in rumination (Michl et al., 2013; Nolen-Hoeksema, Larson, & Grayson, 1999).

2.2.1. Childhood maltreatment

An additional stressful context associated with ruminative style is childhood neglect and abuse. Our model proposes a direct relationship between maltreatment in childhood and the consolidation of ruminative responses (i.e., Consolidation Pathway). Maltreating contexts are often characterized by low positive reinforcement and high levels of negative reinforcement and punishment (Erickson, Egeland, & Pianta, 1989). These environments may fail to reinforce active, problem-focused strategies for regulating emotions (i.e., approaching and tolerating emotion), instead socializing passive responding (O'Mahen, Karl, Moberly, & Fedock, 2015). Abuse is also marked by inconsistency, manipulation, and uncertainty, creating an environment where the child may need to adopt a passive style that is vigilant to signs of threat outside their control. Such a context may discourage externally-oriented problem solving behavior and increase internal focus in order to anticipate and "resolve" uncontrollable outcomes, increasing the likelihood of developing ruminative responses (Conway, Mendelson,

Giannopoulos, Csank, & Holm, 2004; O'Mahen et al., 2015). This is consistent with the theorizing of Nolen-Hoeksema (1991), who postulated that children who perceive low control over their environment (i.e., via maltreatment) experience learned helplessness and are more likely to develop ruminative styles.

Several empirical studies support these associations; for example, college students (Conway et al., 2004) and adults (Sarin & Nolen-Hoeksema, 2010) who reported histories of childhood sexual abuse were more likely to ruminate. In another study of college students, retrospective reports of emotional abuse were linked to rumination (Raes & Hermans, 2008). In one of the few longitudinal studies examining these relations in adolescents, Padilla Paredes and Calvete (2014) found emotional abuse by parents predicted brooding, and that brooding mediated the link between childhood emotional abuse and depression. Reflection, a more benign subtype of rumination, did not relate to abuse or mediate its relation to depression in these studies, suggesting it is the more maladaptive aspect of rumination (i.e., brooding) that results from abuse and not a tendency to self-reflect more generally.

Of note, the studies presented above exclusively examine a single subtype of maltreatment, so that we cannot determine if associations are due to the unique impact of a specific subtype, or its overlap with other forms of maltreatment. And, most of the research assessing multiple subtypes of maltreatment does not consider the unique effects of each subtype on rumination (i.e., does not consider them simultaneously in a statistical model). For example, Spasojevic and Alloy (2002) found a history of sexual abuse in females, and emotional abuse in both sexes, was related to higher trait rumination in college students. Childhood physical abuse was not related to rumination in this study. In two separate samples, Heleniak et al. (2016) examined associations of physical, sexual, and emotional abuse separately with trait rumination in adolescence. All forms of maltreatment were associated with greater levels of rumination. In this study, rumination also mediated the prospective link between childhood maltreatment and psychopathology. Overall, findings suggest adolescents and adults who experienced maltreatment as children are more likely to develop ruminative responses, but because abuse subtypes were tested separately, we cannot determine unique, subtype-specific effects.

To date, one study has examined the unique effects of five subtypes of childhood maltreatment (emotional abuse, physical abuse, sexual abuse, emotional neglect, physical neglect) as predictors of brooding in a sample of women with elevated depressive symptoms (O'Mahen et al., 2015). All types of maltreatment were positively correlated with brooding, but emotional abuse was the only variable predicting unique variance in brooding. And, consistent with Padilla Paredes and Calvete (2014), reflection was not correlated with any of the childhood maltreatment subtypes. These findings suggest when all forms of abuse and neglect were considered together, only emotional abuse was associated with brooding. The authors suggest physical and sexual abuse often co-occur with emotional maltreatment, and that emotional abuse often precedes and persists beyond other forms of abuse, so the impact of different types of abuse may be explained by the emotional abuse patterns common across all abuse types. It will be important for future research to examine if emotional abuse is uniquely linked to rumination in adolescents, and mechanisms underlying these associations. It is also important to highlight gender differences in maltreatment and rumination, as women are more likely to experience certain types of maltreatment (i.e., sexual abuse, Culter & Nolen-Hoeksema, 1991), and engage in rumination (e.g., Johnson & Whisman, 2013). Studies indicate gender differences in rumination may also be due, in part, to gender differences in responses to maltreatment and early life stress, since in adolescent and adult samples effects are stronger in females than males (Conway et al., 2004; Kim, Jin, Jung, Hahn, & Lee, 2017; LeMoult et al., 2018; Spasojevic & Alloy, 2002).

2.3. The role of parents

The emotional climate of the family, including parenting behaviors, coping suggestions, and the amount of emotion expressed in the family, likely also plays a role in the development of a ruminative style. Our model highlights two pathways through which parents can impact rumination: a relationship between (a) parenting behaviors and the consolidation of ruminative responses (via Consolidation Pathway), and (b) family expressivity and momentary rumination through negative affect (via Distress Pathway).

Watkins and Nolen-Hoeksema (2014) suggest that overcontrolling and negative parenting behaviors (characterized by high psychological control and low autonomy granting) may teach children patterns of passivity and foster perceptions of uncontrollability that can lead to habitual rumination. Nolen-Hoeksema, Wolfson, Mumme, and Guskin (1995) found children of more overcontrolling and intrusive mothers were more helpless and passive when faced with an upsetting situation and, by teachers' reports, in their classroom behaviors. Consistent with principles of operant conditioning, when active, problem-focused responses consistently do not receive positive reinforcement from parents, the contingency learned is that these behaviors are not encouraged (Fester, 1973). This learned passivity or helplessness, in conjunction with not being taught more active coping strategies, may engender passive responding to negative affect that increases the likelihood of developing ruminative responses. Indeed, Dweck (1998) found children who respond to a frustrating task with helplessness (rather than problem-focused strategies) were more likely to engage in ruminative self-focus. As such, our model proposes overcontrolling parenting and lower positive parenting may increase the likelihood of consolidation of ruminative style through reduced positive reinforcement of active coping and socialization of passivity or helplessness.

Several cross-sectional and prospective longitudinal studies support associations between parenting style and trait measures of rumination. For example, in retrospective studies, college students (Spasojevic & Alloy, 2002) and adults (Manfredi et al., 2011) who reported their parents were over-controlling were more likely to ruminate, controlling for levels of psychopathology. These findings were replicated in a prospective, longitudinal study following youth from preschool to adolescence, wherein preschool-aged children with overcontrolling parents evidenced higher levels of trait rumination in adolescence. (Hilt, Armstrong, & Essex, 2012). Further, reduced positive parenting has also been related to rumination. In a multi-wave prospective study, Gaté et al. (2013) found that the frequency of positive parenting behaviors during an observational assessment at age 12 was inversely related to the tendency to ruminate at age 15, but only for girls. Thus, low levels of positive reinforcement from mothers to daughters may engender passive, ruminative styles. Interestingly, in this study positive maternal behaviors predicted rumination prospectively, but the concurrent correlation between these variables was not significant. That positive maternal behaviors predict changes in levels of rumination may suggest the impact of these behaviors on rumination may take a protracted period of time to become established, supporting the link in our model between parenting behaviors and consolidation of trait-like ruminative style. Additional research supports links between parental positive affectivity (Schweizer, Olino, Dyson, Laptook, & Klein, 2018) and maternal positivity (Douglas, Williams, & Reynolds, 2017) on child and adolescent rumination, respectively. This indicates high levels of parental positivity may promote more active response styles in youth.

Except for one cross-sectional study with a small effect size (Gardner & Epkins, 2012), rejecting and aggressive parenting behaviors do not seem to confer the same vulnerability to a ruminative response style (Douglas et al., 2017; Gaté et al., 2013; Manfredi et al., 2011; Schweizer et al., 2018; Spasojevic & Alloy, 2002). We speculate that, as highlighted by the developmental psychopathology phenomenon of multifinality (Cicchetti & Rogosch, 1996), affectionless/rejecting parenting may be selectively associated with other cognitive processes, such as

negative attributional styles, as it may convey to children they are not competent, lower self-worth, and increase self-criticism (e.g., Alloy, Abramson, Smith, Gibb, & Neeren, 2006).

Parents may also influence the development of rumination through the explicit coping suggestions they provide their children. A few studies have found that greater levels of maternal disengagement coping strategies are associated with adolescent's higher trait-levels of rumination (Abaied & Rudolph, 2011; Stroud & Fitts, 2017). Parents who provide disengagement strategies likely further reinforce passive responding; we speculate, in this context, adolescents may avoid thinking about their problem, suppress their emotions, or that it may be indirectly suggested to them that their parent believes them to be unable to cope, spurring negative affect and rumination. Of note, one study demonstrated maternal encouragement of excessive emotion expression also contributes to rumination (Cox, Mezulis, & Hyde, 2010), particularly if parents fail to provide complementary problem-solving strategies. Interestingly, Stroud and Fitts (2017) also found mother-adolescent relationship quality moderated this association (i.e., high quality relationships buffered against the negative impact of maternal disengagement suggestions), suggesting that other aspects of parent-child relationship quality may be interactively linked to and predict brooding (Ruijten, Roelofs, & Rood, 2011).

In addition to increasing the likelihood of consolidation of a ruminative style, our model suggests another component of the emotional climate, the amount of emotion expressed in the family, influences the development of rumination. We posit high levels of negative expressivity in the home may escalate children's negative affect and model negative self-referential style, fueling rumination by providing negative cognitive content on which to dwell. In support, high levels of family negative expressiveness are linked to increased negative affect, emotion dysregulation, and avoidant coping in youth (e.g., Halberstadt & Eaton, 2002). Expression of negative-submissive emotions (i.e., sadness, guilt, embarrassment) may be particularly relevant to children's engagement in rumination. One study indicated that maternal negative-submissive expressiveness interacted with children's emotional responsiveness to predict children's use of avoidant coping (Goodvin, Carlo, & Torquati, 2006). Rumination-specific research supports these results, as Hilt et al. (2012) demonstrated high levels of negative-submissive family expressivity in preschool-aged children predicts adolescent ruminative responses, but only for children low in temperamental NA (who may be more reliant on family members to cope).

2.4. Genetics

In addition to environmental factors, biological vulnerability, such as genetic factors, may also create a predisposition for the development of rumination. The role of genetics should not be overstated, as twin studies suggest heritability for rumination in children is relatively low, although heritability appears to increase with age, with reported h^2 values of 0.20–0.21 among younger adolescents, 0.32 for older adolescents, and 0.37–0.41 in adults (Chen & Li, 2013; Johnson, Whisman, Corley, Hewitt, & Friedman, 2014; Moore et al., 2013). Although environmental factors may more directly influence the development of rumination, genetic variability may nonetheless play a role, and may attenuate effects of environmental risk.

Numerous studies have attempted to identify specific genetic variants associated with rumination, either directly or in interaction with other risk factors (i.e., stress exposure, maternal depression, pubertal status, or sex). A comprehensive literature review identified 19 publications that included candidate gene analyses predicting rumination as an outcome; we summarize and cite findings in the Appendix (Supplemental Table S1). Studies have examined genetic variants related to numerous biological systems (e.g., HPA-axis functioning, serotonergic, dopaminergic, folate pathway, brain-derived neurotrophic factor [BDNF]), suggesting that multiple biological processes may be involved in the development of rumination. That said, Table S1 should

be interpreted with great caution, as the quality of studies is variable. For example, many of the studies have very small samples by genetic standards (e.g., $Ns \leq 100$).

Following prominent non-replications and concerns about the proliferation of spurious, unreliable findings, some critics have recently advocated for tightened standards for single-variant candidate gene studies, including substantially larger samples and/or independent replications (Johnston, Lahey, & Matthys, 2013). Indeed, some researchers question the utility of this research at all (e.g., Duncan, Ostacher, & Ballon, 2019) although this point has in turn been vigorously debated (Moffitt & Caspi, 2014; Vrshek-Schallhorn, Corneau, & Starr, 2019). Aligning with this controversy, Table S1 paints, in places, an inconsistent and difficult-to-interpret picture. For example, among studies on the BDNF Val66Met polymorphism (the variant most frequently examined in relation to rumination), there are roughly equal groups of samples that find risk is conferred by a) the Val allele, b) the Met allele, and c) neither allele. That said, the inconsistency in findings may also reflect legitimate heterogeneity in effects, potentially a function of key moderators (e.g., age). Moreover, several high-quality studies point to novel genetic markers in biological systems that are understudied in the context of rumination (e.g., dopamine, folate pathway genes), with potential to expand the understanding of underpinnings of rumination in exciting new directions, pending further replication. More research is decidedly needed that incorporates more sophisticated methodological approaches, including genome-wide association studies and polygenic approaches (e.g., polygenic risk scores, multilocus genetic profile scores), which have yet to be applied to rumination. We conclude, based on behavioral genetics data, that there is likely some genetic determinant to rumination, but that it would be premature to make even speculative claims about the mechanistic nature of this genetic risk. We therefore include genetics in our model as a distal risk factor but do not attempt to speculate as to its mechanisms, as it could feasibly occur through numerous pathways (e.g., susceptibility to NA, variability in effortful control, etc.).

2.5. Cognitive control

To understand why some youth with high levels of negative affect develop a ruminative response style and others do not, we now turn to cognitive control. Cognitive control is conceived broadly as the ability to update and control the contents of working memory (WM). The temperamental, environmental, and biological components of our model are predicated on interactions between these factors and cognitive control difficulties. Indeed, these risk factors will likely not lead to the development of a ruminative style in the absence of cognitive control deficits. In specific, our model proposes that not all individuals who engage in momentary rumination in response to negative affect will employ it as a regular, trait-like strategy. Instead, youth who are experiencing distress and unable to flexibly control cognitive processes, such as effectively discarding no longer relevant material from WM, get stuck in a passive loop on the cognitive content (i.e., ruminate). Stated differently, difficulties disengaging from thoughts increases the likelihood youth will engage in rumination, increasing rehearsal effects (i.e., distress automatically cueing ruminative thought) and thus leading to the consolidation of ruminative tendencies into a habitual way of responding to distress (i.e., Consolidation Pathway). Although most research has been cross-sectional and in adult samples, we speculate difficulties with cognitive control emerge early in life (through temperamental effortful control differences) and moderate the development of a ruminative response style in early adolescence.

Per the unity-diversity framework (Friedman & Miyake, 2017), cognitive control consists of a common factor, divided into a general inhibition factor and resistance to proactive interference factor (i.e., inhibition of formerly activated but no longer relevant information), and two specific factors that include updating and monitoring WM and shifting between different mental sets (e.g., Friedman & Miyake, 2004).

Rumination, defined by a perseverative focus on negative content, has been linked to cognitive control deficits that increase the likelihood thoughts will become repetitive (for reviews, see Whitmer & Gotlib, 2013; Koster, De Lissnyder, Derakshan, & Raedt, 2011; Linville, 1996). More specifically, a recent meta-analysis of adult studies by Zetsche, Bürkner, and Schulze (2018) examined the magnitude and pattern of associations between rumination and the different cognitive control functions (i.e., shifting, updating, discarding, and inhibition) in adults. They found rumination is only reliably/robustly related to one specific function, namely difficulties discarding no longer relevant information from WM. This suggests that, consistent with theories on the mechanisms underlying rumination (as well as our model), most individuals who activate negative cognitive content in WM in response to distress (i.e., spontaneously ruminate) are able to disengage from negative thoughts. However, for individuals who show specific difficulty discarding information from their WM, ruminative thoughts persist over time. This prolongs negative affect and cognitions and increases the likelihood of repeated retrieval of negative material. When rumination is well-practiced, it likely consolidates into a trait-like response style (Joormann & Vanderlind, 2014; Koster et al., 2011), as demonstrated by the iterative nature of our model. This is consistent with findings suggesting ruminators exhibit an increased ability to inhibit external distractors unrelated to task demands (Zetsche, D'Avanzato, & Joorman, 2012; Zetsche & Joorman, 2011), especially when maintaining a task goal (Altamirano, Miyake, & Whitmer, 2010). This excessive focus on task (i.e., mental "stickiness") compounded by difficulty removing no longer relevant information, may further contribute to rumination becoming a more consolidated mental habit.

The content of ruminative thought is typically negative in valence, so we would expect that rumination is linked to difficulties exerting cognitive control over emotional material (and particularly, negative content). However, contrary to hypotheses, Zetsche et al. (2018) found valence of the stimuli (i.e., emotional versus neutral) did not moderate the relation between cognitive control difficulties and rumination. This suggests that ruminators may have trouble discarding the contents of WM regardless of the contents being neutral, positive, or negative. Of note, in this meta-analysis emotional stimuli were mixed positive and negative stimuli, so conclusions cannot be drawn about selective difficulty removing negative material from WM. However, a few studies in adults support that rumination is related to difficulty inhibiting negative information (De Lissnyder, Koster, Derakshan, & Raedt, 2010), and mediates the relation between difficulty shifting between negative and neutral stimuli and depression (Demeyer, De Lissnyder, Koster, & Raedt, 2012). This may suggest valence-specific deficits precede the development of rumination; however, the Demeyer et al. (2012) study design only included two time points, precluding tests of causation.

2.5.1. Cognitive control in youth

Research with youth has generally focused more on attentional control (i.e., what kind of information gets into WM) than discarding material from WM. Selective attention patterns in children ages 9–14 indicate that bias away from positive stimuli is linked to rumination, suggesting difficulty orienting to positive information to distract from negative cognitions (Hilt & Pollak, 2013). Surprisingly, ruminators in this sample did not exhibit a bias towards negative stimuli, but rumination has been linked to a bias for sad faces in maltreated youth ages 11–14 (Romens & Pollak, 2012). This suggests attentional biases for emotional material may be present and linked to ruminative styles during late childhood and early adolescence, but valence and sample characteristics are not clear. Moreover, these studies occurred in children before the likely consolidation of response styles; we speculate that attentional biases for emotional information may precede and predict the development of rumination. This is consistent with research suggesting attentional systems develop earlier than, and likely influence, high-order cognitive capacities (Kujawa et al., 2012). That is, attentional biases in younger samples may develop into downstream

cognitive deficits (i.e., difficulty with inhibition) implicated in trait-level rumination (Pine, Helfinstein, Bar-Haim, Nelson, & Fox, 2009). Interestingly, it is possible that rumination could also result in worsening of attentional control over time. Connolly et al. (2014) found that although there was no concurrent association between rumination and a general (i.e., non-emotional) measure of selective attention among youth ages 12–13, rumination predicted worse selective attention 15 months later. If this bi-directional effect were replicated, it may help explain the insidious nature of rumination.

Hilt, Leitzke, and Pollak (2017) extended research on attentional control by utilizing eye tracking to examine how rumination relates to early (i.e., initial orientation) versus later (i.e., sustained maintenance) stages of attentional processes in early adolescence. Rumination was not associated with initial orienting but was associated with longer time spent dwelling on emotional faces, suggesting ruminative styles may be related to difficulties disengaging from emotional stimuli in adolescence, regardless of valence. Importantly, no studies that we are aware of have explicitly tested whether adolescent rumination is associated with difficulty disengaging from emotional stimuli, as this would require utilizing a task with instructions to disengage. An important direction for future research involves examining the association between disengagement difficulties and rumination along with their temporal development.

A handful of studies have also examined difficulties with set-switching associated with adolescent rumination. Most of these studies found that rumination is not concurrently associated with difficulties in shifting sets with non-emotional stimuli (Connolly et al., 2014; Dickson, Ciesla, & Zelic, 2017; Hilt, Leitzke, & Pollak, 2014; Wilkinson & Goodyer, 2006). However, Dickson et al. (2017) found that rumination was linked to self-reported difficulties in set-shifting, and Connolly et al. (2014) that rumination predicted worse set-shifting 15 months later, indicating a possible relationship between rumination and general set-shifting using varied study designs. The only study to test set-shifting using emotional stimuli found rumination was associated with difficulty inhibiting negative information when shifting to positive blocks on an affective go/no-go task among 9–14-year-olds (Hilt et al., 2014).

Overall, these preliminary studies suggest among youth high in rumination, attentional control difficulties for emotional stimuli may be present in late childhood or early adolescence. Mixed findings with respect to valence suggest trait rumination among youth may be linked to difficulties exerting control over all emotionally arousing stimuli. The limited prospective research suggests rumination may become associated with more general cognitive control difficulties over time (Connolly et al., 2014), but more research is needed. Longitudinal designs that disentangle these links and incorporate information processing paradigms in younger samples are vital next steps to elucidate the emergence and consolidation of cognitive deficits.

In addition to the possibility that rumination could make cognitive control difficulties worse, research in temperament suggests these cognitive control difficulties likely emerge very early in life. Effortful control (EC) is a dimension of temperament involving individual differences in self-regulation of affective and behavioral responses, and is defined as the ability to focus or shift attention (i.e., attentional control) and activate and inhibit behavior (i.e., inhibitory control) (Rothbart, 1989). Studies focusing on temperament have demonstrated the combination of high NA and low EC predict rumination in adolescence (Hilt et al., 2012; Verstraeten et al., 2009). High EC may be a protective factor enabling individuals prone to NA to disengage from negative, self-referential thoughts. On the contrary, youth low in EC may struggle to disengage from negative content, resulting in rumination. Evidence for this interaction has not been consistently supported (Arger, Sánchez, Simonson, & Mezulis, 2012; Mezulis, Priess, & Hyde, 2011; Verstraeten et al., 2009), and thus finer-grained research examining how specific aspects of NA (e.g., anger, sadness, fear) and EC (e.g., sustained attention, inhibition) may interact to predict rumination is needed. One

study that took this approach found that temperamental anger, but not sadness or fear, interacts with low inhibitory control in preschoolers to predict rumination in middle childhood (Schweizer et al., 2018).

2.6. Gender

Our model also incorporates gender as a factor increasing the likelihood of consolidation of rumination (i.e., Consolidation Pathway), as research suggests women are more likely than men to ruminate (Johnson & Whisman, 2013), a gender difference also present in adolescents (e.g., Broderick, 1998; Hampel & Peterman, 2005; Li, DiGiuseppe, & Froh, 2006; Mezulis, Abramson, & Hyde, 2002). A meta-analysis of youth samples lends support, finding a very small gender difference in rumination in children ($d = 0.14$) that increases considerably during adolescence ($d = 0.36$) (Rood, Roelofs, Bogels, Nolen-Hoeksema, & Schouten, 2009). In a large sample of youth, Jose and Brown (2008) further demonstrate the onset of gender differences in rumination does not emerge until age 12, after which girls reported higher use of rumination than similar-aged boys. This may, in part, explain the emergence of gender differences in depression in adolescence (Hilt, McLaughlin, & Nolen-Hoeksema, 2010; Jose & Brown, 2008).

Given these findings, we incorporate gender into our model as a factor that places girls at a higher risk for developing a trait-like ruminative style. We speculate rumination is a gender-stereotyped coping strategy acquired in females through socialization processes like modeling and reinforcement (Broderick, 1998; Eisenberg, Cumberland, & Spinrad, 1998). In support, Wupperman and Neumann (2006) suggest the experience and expression of emotion is identified as stereotypically female and socially prescribed and reinforced in girls. Over time, females' sensitivity to and expression of emotion in the self and others becomes internalized and guides behavior. As such, many individuals who identify with a more feminine gender role have increased expressed emotionality and emotional attunement. These characteristics are linked to increased self-focus and NA, both of which may promote higher levels of engagement in rumination in females (Ingram, Cruet, Johnson, & Wisnicki, 1998).

Once rumination is initiated in girls, it is also more likely to continue due to its consistency with coping styles and cognitive beliefs associated with socialized female gender roles. This increases the likelihood that rumination will consolidate into a stable, trait-like style. In support, a couple of studies demonstrate self-reported stereotyped femininity is linked to trait-level rumination (Conway, Giannopoulos, & Stiefenhofer, 1990; Li et al., 2006), and that endorsement of a more feminine role identity in childhood mediates associations between gender and rumination, especially rumination over interpersonal events (Cox et al., 2010; Simonson, Mezulis, & Davis, 2011). This stands in contrast to males, who are more often socialized to disengage from their emotions and utilize active, problem-focused coping.

2.7. Mechanisms linking developmental factors across domains

To date, most studies have examined the main effects of each risk factor on the development of rumination, so support for mediational and moderational interplay is limited. However, it is unlikely that these factors operate independently, and emerging literature is beginning to examine mechanisms through which risk factors interact. For example, prospective studies suggest joint effects of temperamental vulnerability and parenting on the development of rumination (Hilt et al., 2012; Schweizer et al., 2018). Early life stress, parenting behaviors, and temperament have also been linked to the development of general and valence-specific cognitive control deficits (e.g., Bernier, Carlson, & Whipple, 2010; Lonigan & Vasey, 2009), factors that are implicated in rumination. It is important to note that for ease of interpretation and translatability, our model does not capture every association or interaction between variables.

3. The emergence and consolidation of ruminative response style

Developmental theories examining age-related changes in cognitive vulnerabilities suggest engagement in rumination may emerge in childhood and stabilize into an enduring, trait-level response style linked to psychopathology during the transition to adolescence. We suggested earlier that certain risk factors contribute to the likelihood of consolidation and speculate this is associated with changes in physical and cognitive development, as well as a 'practice effect' (i.e., the more often a cognitive style is rehearsed the more likely it is to become a habitual response) (Watkins & Nolen-Hoeksema, 2014). Several factors are likely at play, including negative reinforcement (i.e., reductions in distress from withdrawing from aversive situations, or from a sense of certainty about one's conclusions; Fester, 1973; Martell, Addis, & Jacobson, 2001; Nolen-Hoeksema et al., 2008). Of note, empirical support for the emergence (i.e., when a risk factor begins to predict increases in psychopathology) and stabilization (i.e., the structure and organization of the vulnerability factor over time) of ruminative styles is in its early stages. As such, we first look to research examining mean-level change and differential stability of related cognitive styles; these studies suggest cognitive styles have largely stabilized in adolescence, but that change exists alongside this continuity (Caspi, Roberts, & Shiner, 2005).

For example, several studies indicate negative cognitive styles exhibit mean-level stability and moderate rank-order stability in early to middle adolescence (Hankin, 2005, 2008; Hankin, Fraley, & Abela, 2005; Mezulis, Funasaki, & Hyde, 2011). Negative cognitions in adolescence are also structured in a trait-like manner, so as the length of test-retest intervals increases, test-retest correlations remain invariant (Fraley & Roberts, 2005). In addition, trait-state-occasion modeling demonstrates age-related increases in children's internal, stable, and global attributional styles, such that the trait-like component of attributional style was not evident in young children, emerged in late middle childhood, and intensified in early adolescence (Cole et al., 2008). Cole and colleagues posit as mean-level stability of attributional styles increases with age, its correlations with related constructs like rumination change in similar ways. This is supported by factor analytic studies suggesting cognitive vulnerabilities become more interrelated during the transition to adolescence (Adams, Abela, & Hankin, 2007). While this supports the consolidation of cognitive style during early adolescence, a few studies indicate modest stability estimates for cognitive vulnerabilities in middle childhood, but with substantial variability in individual trajectories (Hayden et al., 2013; Hong, Lee, Tsai, & Tan, 2017). These inconsistencies may be attributed to methodological factors like sample characteristics, follow up length, and measures used; continued work is needed to investigate these questions.

To date, three studies have examined developmental trajectories of ruminative styles. Heleniak et al. (2016) followed a large sample of adolescents over three timepoints from grades 8–12. Using multi-level modeling, findings suggest levels of brooding remained stable across the adolescent period. This is consistent with other work demonstrating moderately strong relations between subsequent measures of rumination in a large, population-based sample of adolescents (ages 13–14) over 3 years with annual assessments (Mazzer, Boersma, & Linton, 2019). Hankin (2008) also studied the stability of ruminative styles in adolescents (6th–10th graders) over four waves of data, each 5 weeks apart. This sample exhibited mean-level change in the form of decreasing rumination over time, but the effect was driven by a large drop in time 4 scores, as means were stable from times 1–3. Analyses conducted among subsamples of early and middle adolescents showed middle adolescents' ruminative response style exhibited mean-level stability. These age effects suggest alongside some continued change, rumination evolves into a more stable, trait-like vulnerability as a function of increasing grade. Test-retest correlations evaluating differential stability for rumination were moderate, and the trait model exhibited good fit, suggesting enduring processes best explain the

magnitude of test-retest correlations. Overall, patterns suggest a ruminative style may coalesce into a trait-like quality in adolescence. However, stability and change coexist, so increases in the frequency and intensity of negative affect may cause rumination to be more chronically active for certain adolescents.

Moreover, we suggest ruminative styles consolidate in adolescence based on research indicating age differences in the impact of rumination on the development of psychopathology. More specifically, meta-analytic evidence suggests effect sizes for the relation between rumination and both concurrent and prospective depressive symptoms were higher for adolescent than child samples (Rood et al., 2009). We speculate this increase in predictive utility suggests that rumination becomes a more stable, and more emotionally pernicious, trait in adolescence.

Finally, research on changes in emotion regulation strategies across development suggests age-dependent increases in emotion-focused coping among children and adolescents, indicating these strategies may be less utilized in children (e.g., Compas, Malcarne, & Fondacaro, 1988; Donaldson, Prinstein, Danovksy, & Spirito, 2000; Nolen-Hoeksema et al., 1995). Studies assessing mean-level change found rumination increases from childhood through adolescence (Baiocco et al., 2017; Hampel & Peterman, 2005; Jose & Brown, 2008). Research also demonstrates inconsistent response styles in young children, both across time and within a testing session, further suggesting unstable response styles until early adolescence (Abela et al., 2002; Abela et al., 2004; Driscoll, 2004; Turner & Cole, 1994). For example, Abela et al. (2004) examined relations between three response styles and depressive symptoms in third and seventh graders. Seventh graders exhibiting a tendency to ruminate engaged in less distraction and problem-solving than non-ruminative peers. However, third graders who engaged in more rumination utilized more distraction and problem-solving than did non-ruminative peers. Overall, these findings indicate children may engage in rumination, but not develop stable response styles until the transition to adolescence due to cognitive development and brain maturation, as described below, as well as increases in stressors during this developmental period.

3.1. Normative maturational processes implicated in rumination

To examine consolidation of ruminative styles in youth, the development of maturational processes implicated in rumination must be considered. Cognitive development, brain development, and pubertal timing all have implications for the development of rumination.

3.1.1. Cognitive development

Negative self-referential cognitions initiate and perpetuate the tendency to ruminate, but adult models of rumination do not account for the development of cognitive skills required to think about stable and global causes, and negative consequences, of distress. Research suggests stable cognitive styles may not develop until early adolescence, a period wherein capacity for formal operational thought emerges (Turner & Cole, 1994). This ability to reason abstractly leads to development of a stable conception of self, an understanding of causality, and a conceptualization of sequencing of events, capacities central to rumination.

As children develop, their capacity for abstract reasoning enables the development of a more stable and less concrete sense of self (Rotenberg, 1982). Children through age seven do not understand that dispositional traits are constant over time or across situations (Rholes & Ruble, 1984; Rotenberg, 1982). In middle childhood a rudimentary conception of self emerges and by early adolescence stable, trait-like characteristics and abstract psychological constructs can be applied to one's self and others consistently over time and across situations (Harter, 1986). The ability to use stable personal characteristics to explain behavior, events, and expectations in adolescence facilitates awareness of the causes of, and one's role in, outcomes, a capacity central to rumination. In a review, Ellis and Hudson (2010) indicated

that the capacity to reason about causes of events and generate alternative outcomes increases with age. For example, young children have some ability to reason about causal events, but are likely to make errors in causality due to over-attributions of intentionality and difficulty differentiating between internal and external motivation (Kaslow, Adamson, & Collins, 2000). By middle childhood, children can use internal factors to explain events, a pattern that increases in stability with the development of enduring self-concept. Finally, in order to persevere on the consequences of one's distress, a future time orientation is required. This skill emerges at around age 8 (Wallace & Rabin, 1960) and improves into adolescence with the ability to assess probabilities (Kaslow et al., 2000). In sum, cognitive maturation leads to the development of a stable self-concept that enables an increased ability to understand causality and possess a future time orientation, skills associated with an increased capacity for rumination.

3.1.1.1. Metacognition. Engagement in rumination is also perpetuated by metacognitive beliefs that promote self-reflective, emotion-focused coping (Papageorgiou & Wells, 2001), capacities that develop in adolescence (Cartwright-Hatton et al., 2004). Metacognition involves metacognitive knowledge and metacognitive regulation (Vasey, 1993). Metacognitive knowledge emerges early in life; by age 3 children have some awareness of their own and others mental states (Flavell, 1999). These capacities increase with age, maturing steadily in late childhood and adolescence (Flavell, Green, & Flavell, 2000; Schneider, 2008). Metacognitive regulation, or the ability to attend to one's cognition and select and appraise one's regulatory strategies, emerges later than metacognitive knowledge, likely in late childhood and early adolescence (Schraw & Moshman, 1995). This is bolstered by evidence indicating that in adolescence, as compared to early and middle childhood, there is an awareness that thoughts may be difficult to control, knowledge that requires thought monitoring to generate. In addition, a study on the development of metacognitive monitoring of self-performance found metacognitive regulation improves with age, peaking in late adolescence and plateauing in young adulthood (Weil et al., 2013). Overall, children exhibit rudimentary awareness of their own thoughts but difficulty monitoring and regulating cognition, capacities central to rumination. These abilities appear to develop in adolescence, a period wherein stable ruminative styles consolidate.

3.1.2. Brain development

The brain develops dynamically, with significant structural changes in the frontal lobes and functional changes related to patterns of connectivity emerging throughout adolescence. The default mode network (DMN), a network of functionally correlated structures including the medial prefrontal cortex (mPFC) and posterior cingulate cortex (PCC), has been linked to rumination in studies using functional magnetic resonance imaging (Hamilton, Farmer, Fogelman, & Gotlib, 2015). Because the DMN is thought to support the ability to engage in self-referential thinking, its development is likely necessary for rumination to develop as a response style. Research on the development of the DMN suggests that it becomes increasingly connected from childhood to adulthood (Fair et al., 2008) with greater connection between the PCC and mPFC developing during adolescence (Sherman et al., 2014). This lends support to the idea that rumination may become more trait-like during adolescence due to support from typical brain maturational processes.

Specific research linking brain network coherence to rumination is sparse. One study of early pubertal children did not find an association between DMN and rumination but did find an association between coherence within the salience network and rumination (i.e., brooding) for girls only (Ordaz et al., 2017). It will be important for future research to examine whether coherence in DMN (or other brain networks) is associated with rumination in older adolescents.

3.1.3. Puberty

Although pubertal onset temporally coincides with increases in rumination, there is little evidence that pubertal maturation directly contributes to likelihood of developing a ruminative style (Alloy, Hamilton, Hamlat, & Abramson, 2016), albeit little research has examined this question. Some evidence suggests that early pubertal timing (i.e., advanced pubertal development relative to same-age peers of the same sex), an apparent transdiagnostic risk factor for the development of psychopathology in youth (e.g., Hamlat, Snyder, Young, & Hankin, 2019), predicts prospective increases in rumination among girls (Alloy et al., 2016). However, it is likely that early pubertal timing simply functions as a stressful context, influencing the development of a ruminative style via the Distress Pathway.

4. Conclusions, future directions, and clinical implications

We have presented a novel model for the emergence and consolidation of ruminative response style. Our review also identified gaps in the literature, which will be important to address in future studies. To date, most studies on the developmental origins of ruminative style have a) relied on self-report questionnaires to measure one's general tendency to ruminate, b) identified main effects of specific risk factors on the development of rumination, and c) used cross-sectional designs. These methodological limitations are such that direct support for the integrative pathways likely leading to engagement in rumination, as well as the transition from occasional rumination to a habitual ruminative style, are understudied. The lack of validated assessments in young children has been a limiting force in the child literature, and more research is needed that utilizes creative, developmentally-sensitive approaches (Baiocco et al., 2017).

Further, it will be important for future studies to examine the interplay between factors, as well as use longitudinal designs to test causal models. For example, we speculate that moderating factors (e.g., parenting, effortful control, maltreatment history) would increase the likelihood that a ruminative response style develops following elevations of negative affect (e.g., due to stressors). More research should also incorporate ecological momentary assessment and laboratory-based designs with traditional methods to distinguish between how developmental factors differentially influence state versus trait rumination. And, research examining the origins of reflection is needed, as it appears that different factors might impact its development. Further, increasing research has focused on positive rumination (e.g., savoring, dampening; Li, Starr, & Hershenberg, 2018), and an important area for future research will be to identify developmental antecedents and mechanisms for these forms of perseverative thought.

We have also presented literature on the changes and stability of cognitive vulnerability factors to suggest individual differences in rumination may consolidate into enduring, trait-level response styles during the transition to adolescence. It is important to consider that research assessing the stability of rumination in particular is limited, so that future work must utilize multiple samples across development to examine stability over time. Additionally, work on brain maturation as it relates to the development of rumination in youth is lacking and may benefit from measuring rumination in studies of structures related to the DMN.

Elucidating when ruminative style functions as a trait-like response style will improve theoretical understanding of rumination, and inform developmentally sensitive prevention and intervention efforts. If ruminative style stabilizes in early adolescence, implementing interventions for adolescents targeting mechanisms underlying the development of rumination is crucial. Based on our model, there are two obvious areas for preventive intervention: reducing negative affect and improving cognitive control. Reducing negative affect might be a helpful target both in early childhood and throughout the lifespan because of the iterative nature of the distress-rumination cycle. Targeting parental control is one potential avenue for a preventative intervention in this

vein. Several intervention programs exist to help parents focus on positive behaviors, but few focus explicitly on decreasing over-controlling behaviors. In addition, because rumination is linked to difficulties in inhibitory processes, targeting control and disengagement of attention may be especially helpful in preventing the consolidation of rumination into a trait-like style. Mindfulness and other forms of attention training have been helpful in this regard. Mindfulness helps focus attention on the present moment and has had success preventing recurrence of depression through the mediating role of reducing rumination (Ma & Teasdale, 2004). Less work has been done using mindfulness to target rumination or depression in youth, but preliminary research is promising (Hilt & Pollak, 2012; Raes, Griffith, Van der Gucht, & Williams, 2014).

A cognitive-behavioral therapy specifically targeting rumination has also been developed, i.e., rumination-focused cognitive-behavioral therapy (RF-CBT; Watkins, 2016). In this treatment, individuals are taught to notice when rumination occurs and to minimize cues and develop alternative ways of coping. A group- and internet-based version of RF-CBT, tested in a randomized controlled trial with adolescents, was found to reduce depression and anxiety, with reductions in rumination and worry mediating these effects (Topper, Emmelkamp, Watkins, & Ehring, 2017). Overall, understanding the interplay and timing of various factors that may lead to the development of a ruminative response style will elucidate optimal targets and timing of preventive interventions.

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Contributors

Zoey A. Shaw, Lori M. Hilt, and Lisa R. Starr designed the study. Zoey Shaw conducted literature searches and wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

Declaration of competing interest

The authors declare that they have no conflicts of interest.

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Appendix A. Supplementary data

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