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Attachment and brooding rumination during children's transition to adolescence: the moderating role of effortful control

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ABSTRACT

Brooding rumination is a maladaptive form of emotion regulation and confers a risk for psychopathology. Insecure attachment and low cognitive self-regulation are important antecedents of brooding. Yet, little is known about the developmental interplay between these two systems. Thus, we tested how children's attachment and cognitive self-regulation, conceptualized as effortful control (EC), interact to predict brooding. The participants in the three-wave longitudinal study were n = 157 children (10 to 14 years) and their mothers. Children reported their attachment and brooding, and mothers reported children's EC. Results showed that children with low avoidance received benefit from high EC to decrease brooding, whereas children with high anxiety brooded irrespective of EC. Thus, high EC may foster constructive emotion regulation among securely attached children, whereas the beneficial effects of high EC on emotional functioning seem to be overridden by insecurity. The functional role of cognitive self-regulation on different attachment strategies is discussed.

Introduction

Children are highly dependent on the support from their caregivers yet strive towards emotional autonomy when transitioning from childhood to adolescence (Allen & Tan, 2016). Learning new ways to regulate own emotions can be challenging during this turbulent period, and indeed, emotional problems tend to rise in early adolescence (Cracco et al., 2017). Brooding (i.e. focusing repeatedly on negative thoughts and mental content) is a dysfunctional form of emotion regulation and closely links to the development of mental health problems (Nolen-Hoeksema et al., 2008; Shaw et al., 2019). Previous research has identified insecure parent-child attachment, that is, lack of trust in caregiver support during distress, to increase worry and brooding (Van de Walle et al., 2016). Likewise, children's cognitive self-regulatory capacities and skills have been recognized as important determinants of brooding (Shaw et al., 2019). Without cognitive skills to inhibit the processing of negative information children have difficulties to regulate

brooding (Koster et al., 2011). Despite this understanding, previous research has not tested how attachment and cognitive self-regulation interplay and together explain brooding. This would be important to both depict the development of brooding and better understand the dynamics between attachment and cognitive self-regulation. In the current study, we conceptualized cognitive self-regulation as effortful control (EC), defined as one's ability to control attention and inhibit or activate behaviors as needed (Rothbart, 1989). We test how children's attachment anxiety and avoidance interact with EC to predict brooding, and explore whether the function of attachment and EC on brooding varies according to child's age from middle childhood to early adolescence.

Parent-child attachment during transition to adolescence

The attachment system regulates distance and proximity-seeking to attachment figure(s) (Bowlby, 1982). In the context of sensitive parental caregiving, children tend to develop a secure attachment, characterized by trust in the availability and benevolence of the parent. In contrast, in the context of insensitive or unresponsive caregiving, children experience insecurity and develop secondary attachment strategies (Main, 1990; Mikulincer & Shaver, 2019). These strategies are typically characterized by either anxious attachment, referring to a tendency to hyperactivate the attachment system to obtain parental protection, or attachment avoidance, referring to a tendency to deactivate the attachment system to limit further experiences of rejection. The attachment system is continuously shaped and updated by age salient experiences in close relationships through different developmental periods (Bosmans et al., 2020; Fraley & Roisman, 2019).

   During the transition from childhood to adolescence children face the developmental task of acquiring autonomy while maintaining relatedness with the parents (Allen & Tan, 2016). Parent-child conflicts typically peak in early adolescence (Granic et al., 2003) and peers become gradually important sources of emotional support (Allen & Tan, 2016). Concomitantly, it is typical for adolescents to experience decline in attachment related trust (Ebbert et al., 2019) and increase in attachment avoidance towards own parents (Theisen et al., 2018; Weymouth & Buehler, 2016). This autonomy development is fostered by brain maturation and development, that establishes greater and increasingly complex forms of self-regulation (Ahmed et al., 2015). Despite this, the transition can be emotionally challenging, as evidenced by the typical onset of emotion regulation difficulties and mental health problems in adolescence (Cracco et al., 2017; Madigan et al., 2016). While adolescents increasingly rely on their own abilities and peers, parents still continue to be the primary attachment figures and source of support (Allen & Tan, 2016; Flykt et al., 2021).

Attachment and brooding rumination

Secure attachment fosters children's and adolescent's emotion regulation development, whereas insecure attachment relates to difficulties in emotion regulation (Brumariu, 2015; Cooke et al., 2019). Amongst others, insecurely attached children and adolescents often develop the tendency to ruminate on personal concerns and negative effects (Margolese et al., 2005; Ruijten et al., 2010; Van de Walle et al., 2016; Van Durme et al., 2018). While rumination may be a regulatory attempt to better understand oneself and repair mood, it typically exacerbates negative emotions (Koster et al., 2011; Résibois et al., 2017) and

heightens depression (Aldao et al., 2010; Olatunji et al., 2013). Treynor et al. (2003) distinguished two subdimensions of rumination. Brooding (also known as brooding rumination) is a persistent, judgemental, and passive comparison of one's current situation with some unachieved standard. In contrast, reflection is a more voluntary and neutral form of turning inward to engage in problem solving. While the distinction is not accounted for in all studies, brooding is considered more central for emotional well-being than reflection (Olatunji et al., 2013). Indeed, brooding, but not reflection, has been found to mediate the effects of attachment insecurity on depression (Cortes-Garcia et al., 2020). Thus, due to its high clinical and theoretical relevance, we focus only on the brooding in the current study.

While attachment insecurity may increase brooding (i.e. worries about not being safe), the effects may be more complex when considering the secondary attachment strategies. Anxious attachment has been suggested to have particularly close connection with the brooding (Dykas & Cassidy, 2011; Mikulincer & Shaver, 2019). As a part of their hyper-activation strategy, anxiously attached children and adolescents tend to heighten own negative emotions and exaggerate experiences of vulnerability. In keeping with this perspective, empirical studies show a robust association between attachment anxiety and brooding (Van de Walle et al., 2016; Van Durme et al., 2018; Verhees et al., 2021). In contrast, as a part of their deactivation strategy, avoidantly attached children tend to hide negative emotions and suppress attachment needs (Dykas & Cassidy, 2011; Mikulincer & Shaver, 2019). Interestingly, however, empirical data is mixed regarding the link between brooding and avoidant attachment: Most studies have found no association between avoidant attachment and brooding (Van de Walle et al., 2016; Van Durme et al., 2018), whereas some have found a positive association (Caldwell & Shaver, 2013; Lanciano et al., 2012). These results are perplexing, as per the theory, avoidant children could be expected to show less brooding to achieve their deactivation goals. It is possible that some yet unidentified factors determine when avoidant attachment leads to heightened brooding, and when it leads to suppression of brooding. Yet, such moderating factors have not been analyzed in the previous research. In the current study, we examine the role of cognitive self-regulation moderating the link between attachment anxiety and avoidance with brooding.

The role of effortful control

Cognitive self-regulation involves multiple processes that allow one to establish flexible top-down control of own behavior in the context of prevailing goals (Carter & Krug, 2012; Nigg, 2017). Low cognitive self-regulation can heighten brooding by making it difficult to stop the processing of negative self-referential information (Koster et al., 2011). For example, difficulties in regulating own attention and the content of working memory can make it difficult to disengage from brooding. Temperament research calls individual differences in these abilities *effortful control* (EC), referring to child's ability to utilize attention and to inhibit behavioral responses in the service of self-regulation (Nigg, 2017; Rothbart, 1989). While EC is typically assessed using questionnaire methods, it strongly overlaps with behavioral assessments of self-regulation (i.e. executive control; Bridgett et al., 2013; Kim-Spoon et al., 2019).

Two meta-analyses show that low cognitive self-regulation associate with brooding, yet the associations have been surprisingly small in size (Vălenaş & Szentágotai-Tătar, 2017; Zetsche et al., 2018). Hence, it has been suggested that low EC may lead to the development of brooding only in the presence of other complicating factors (Shaw et al., 2019). In line with this, parenting research has found EC to moderate the effect of parenting quality on brooding. More specifically, high EC predicts low brooding when children receive sensitive parenting (e.g. high warmth), but has less impact on brooding when children receive insensitive parenting (e.g. harshness or overcontrolling) (Hilt et al., 2012; Schweizer et al., 2018). This implies that high EC may provide added benefit for the children who receive sensitive parenting, rather than protecting them from brooding in the context of insensitive parenting. Applying this idea could help explain the inconsistent associations, in the past research, between brooding and EC, as well as between brooding and attachment.

The current study

In the current study, we study how children's EC and perceptions of own attachment interact to predict brooding. We used data from a three-wave longitudinal study (one year between each wave) during the children's transition from middle childhood to adolescence (between 10 and 14 years). To the best of our knowledge, the moderating role of EC has not been previously tested in attachment research. Thus, considering the links between child's attachment and parenting quality (Jones et al., 2015), we derive our first hypothesis from the parenting research (Hilt et al., 2012; Schweizer et al., 2018). We deem it possible that securely attached children with high EC show especially low levels of brooding. This would indicate that high EC fosters the implementation of the constructive and security-based regulatory strategies (e.g. support-seeking) that limit the occurrence of brooding. Thus, we hypothesized that children with low attachment anxiety and avoidance (i.e. high attachment security in the dimensional model) with high EC show very low levels of brooding. We call this a *dual benefit effect* hypothesis.

Moreover, considering the role of insecure, secondary attachment strategies on emotion regulation, the attachment X EC interaction may occur differently for more anxiously versus avoidantly attached children. Brooding likely aligns with the hyperactivation goals of anxiously attached children as it heightens negative experiences (Mikulincer & Shaver, 2019). As such, anxiously attached children may perceive it unnecessary to utilize their EC to suppress brooding. Thus, we hypothesized that children with high scores on attachment anxiety show high levels of brooding irrespective of their EC. We call this a *brooding hyperactivation* hypothesis.

In contrast, avoidant children may refrain from brooding if they have the high EC capacity to accomplish this. Some empirical basis for this is available from experimental exhaustion studies showing that the deployment of avoidant deactivation strategies require self-regulatory capacity (Chun et al., 2015; Kohn et al., 2012). When this capacity has been exhausted (or is lacking) the negative attachment memories (e.g. concerning rejection and failure) become highly accessible for avoidant individuals. Thus, we hypothesized that children with high scores on attachment avoidance with high EC show lower level of brooding than high avoidant children with low EC. We call this a *cognitive deactivation* hypothesis.

The transition from middle childhood to adolescence involves simultaneous changes in children's attachment, cognitive self-regulation, and emotional functioning. Thus, we examined whether child's age moderates the effects of EC and attachment on brooding. As children become more autonomous in emotion regulation and attain higher self-regulation capacity when they grow older, we hypothesized EC to be more important for brooding among older children. This hypothesis also aligns with a previous study showing the increasing importance of EC on emotional well-being from middle childhood to late adolescence (Snyder et al., 2019). However, due to the lack of previous studies, we did not pose more specific hypotheses regarding the more complex age-dependent dynamics among predictors of brooding (i.e. age × attachment × EC interaction). As child's gender and family socioeconomic status can influence attachment, EC, and brooding, we consider them as covariates in all analyses.

Methods

Participants and study design

Participants were a community sample of 157 children (76 boys) and their mothers living in an urban Belgian area. They were assessed annually over a three-year period (T1-T3). At each assessment, the children reported their attachment and brooding rumination, and mothers reported child's effortful control. At time 1 (T1) the children were approximately 11 years old (M = 10.91, SD = 0.87, range = 9.08–12.90). The total three-wave data covered an age-range from 10 to 14 years (5% trimmed range = 9.87–13.91). In the beginning of the study recruitment took place by distributing invitation flyers to the fifth and sixth-grade classrooms in 16 elementary schools. Each time of assessment, the participants visited research facility. The child and the mother filled out questionnaires in separate rooms and both received small compensation (e.g. movie ticket) for participating in the study. Children provided informed assents and mothers informed consents at the beginning of the study. The study procedure was approved by the university's ethical committee.

At T1, a majority of 120 (76.4%) children were from intact families, 34 (21.7%) children had divorced parents, and 3 (1.9%) lived in another family structure. Furthermore, 155 (98.7%) children reported attachment towards their biological mother, while two (1.3%) children reported attachment towards their adoptive mother. With regard to parental education level, 33 (21.0%) mothers, and 48 (30.6%) fathers had a primary or secondary-level education (e.g. vocational training), and 124 (79.0%) mothers and 109 (69.4%) fathers had highest level education (e.g. bachelor's or master's degree).

Attrition was low over time, with 146 (93%) children and 143 (91.1%) mothers participating at Time 2 (T2), and 133 (85%) children and 129 (82.2%) mothers participating at Time 3 (T3). Altogether, 127 (81.9%) children and mothers participated at all three time points. Missing values within each time point were present only for 10 (6.3%) children at T1, 2 (1.4%) children at T2, and 4 (3.0%) children at T3. Importantly, Little's MCAR test showed that attrition and missing values in the data occurred completely at random, $\chi^2(238) = 262.72$, $p = .130$. Thus, all the available data (403 data points) were used in the main analyses.

Measurements

Children's attachment style

Children's perceptions of their attachment anxiety and avoidance were measured using Experiences in Close Relationships Scale–Revised Child version (ECR-RC) (Brenning et al., 2011, 2014). ECR-RC is a self-report questionnaire modified from the adult version Experiences in Close Relationships Scale–Revised (ECR-R) (Fraley et al., 2000). The child version involves slightly simplified items and revision of the content to be pertinent to the parent–child bond. It allows to assess children's attachment in relation to both parents, yet, in the current study only the items referring to the mother were used. Children used a 7-point Likert-type scale to answer items on *attachment anxiety* (six items, e.g. "I'm worried that my mother doesn't really love me" and "I sometimes think my mother has changed his/her feelings about me without any reason") and *attachment avoidance* (six items, e.g. "I don't like telling my mother how I feel deep down" and "When I feel bad, it helps to talk to my mother," reverse scored). In line with dimensional approach to attachment, higher scores indicate higher attachment anxiety and avoidance, whereas lower scores indicate higher attachment security. In the current sample, internal reliabilities were satisfactory for attachment anxiety (Cronbach α's range: .79 to .86) and avoidance (Cronbach α's range: .71 to .86) from T1 to T3. The reliability and construct validity of these scales have been demonstrated in both clinical and community samples (Brenning et al., 2011, 2014; Van de Walle et al., 2016).

Children's brooding rumination

Brooding was measured using the brooding dimension from the extended version (Verstraeten et al., 2010) of the Rumination subscale from the Children's Response Styles Questionnaire (CRSQ) (Abela et al., 2004). The extended version of the self-report questionnaire includes slightly simplified items more early to be understood and newly added items to better capture brooding. Children used a 4-point Likert scale to answer 5 items on brooding (e.g. "When I am sad, I think about a recent situation wishing it had gone better" and "When I am sad, I think: "What am I doing to deserve this?""). Internal reliability was satisfactory (Cronbach α"s range: .73 to .76) from T1 to T3. The validity of the scale has been demonstrated in previous studies (Verstraeten et al., 2008, 2010) and the content of the items parallel those frequently used in adult studies (Treynor et al., 2003).

Children's effortful control

Effortful control was assessed through maternal reports on the Early Adolescent Temperament Questionnaire – Revised (EATQ-R) (Ellis & Rothbart, 2001). It is a revised and updated version of the Early Adolescent Temperament Questionnaire (EATQ) (Capaldi & Rothbart, 1992), suitable for children and adolescents from 9 to 15 years of age. Only the effortful control factor (18 items) was used in the current study. Mothers used a 6-point Likert-scale to answer items on their child's *attentional control* (e.g. "It is easy for my child to really concentrate on homework problems"), *inhibitory control* (e.g. "When someone tells my child to stop doing something, it is easy for him/her to stop"), and *activation*

control (e.g. '"If my child has a hard assignment to do, he gets started right away"). The total score had satisfactory reliability (Cronbach α"s range: .90 to .90) from T1 to T3. The validity of the scale has been demonstrated in several studies (Ellis & Rothbart, 2001; Verstraeten et al., 2010).

Child's age and covariates

Child's Age was measured at each three assessment points. To allow modeling of possible nonlinear age-related changes, the age variable was categorized into five categories: 10-year-old (range = 9.08–10.50; n = 59), 11-year-old (range = 10.51–11.50; n = 112), 12-year-old (range = 11.51–12.50; n = 133), 13-year-old (range: 12.51–13.50; n = 92), and 14-years-and-over (range: 13.53–15.09; n = 40). Parental education level was computed as an average of mother's and father's education (1 = primary, 2 = secondary, 3 = highest level of education) assessed at T1. The covariates also included child's biological sex (1 = male, 2 = female).

Statistical analyses

The main analyses were conducted with Generalized Estimating Equations (GEE) implemented in SPSS 25.0. GEE is a flexible regression-based approach that can effectively deal missing data and model dependencies in longitudinal data. The main GEE model used Brooding as the dependent variable and Time (T1-T3) as the within-subject factor. Attachment Anxiety, Attachment Avoidance, and EC were included as continuous independent variables, and Child's Age as independent factor. Two-way interaction terms between attachment (anxiety and avoidance) and EC, as well as the three-way interaction terms involving Child's Age were included in the model. Parental Education and Child's sex, as well as their two-way interaction terms with the main study variables, were used as covariates. Continuous independent variables were standardized before the analysis. GEE provides Wald Chi-Squared Tests (χ^2) for model parameters. False discovery rate (FDR) correction based on two-stage sharpened method (Benjamini et al., 2006) was used to control for multiple statistical test concerning research questions (i.e. 10 *p*-values). All model parameters and uncorrected *p*-values are shown in Table A1 in Appendix. Guided by goodness-of-fit statistics (QIC) the GEE model used exchangeable working correlation matrix and gamma distribution with log link function.

Post hoc tests for interaction effects involving continuous variables (i.e. attachment and EC) predicting brooding were conducted using Regions of Significance (RoS) analysis (Preacher et al., 2006). Asymptotic covariance matrix produced by GEE was used to obtain two boundary values that indicate the region of the moderator variable in which the effect of independent variable is significant on the dependent variable. If one boundary value falls outside of the empirical range of the moderator variable, the other boundary value is sufficient to indicate the region of significance. To foster interpretation, interaction effects for continuous variables were visualized using beta coefficients and traditional cutoff scores of ±1*SD. Post hoc analyses for interaction effects involving child's categorical age were conducted with separate GEE analyses for selected age groups.

Results

Descriptive statistics

For descriptive purposes, means, standard deviations and correlations for the main study variables are shown in Table 1. The correlations show, for example, moderate association between attachment anxiety and avoidance at all time points. Furthermore, there were moderate association between attachment anxiety and EC at T2 and at T3, but not at T1. There were no associations between attachment avoidance and EC at any time point.

Descriptive GEE models showed that girls had higher EC than boys, χ^2 (1) = 4.78, B = .04, SE = .02, p = .029. Furthermore, higher parental education predicted children's higher EC, $\chi^2(1)$ = 12.44, B = .06, SE = .02, p < .001. Regarding developmental changes, child's age predicted attachment avoidance, $\chi^2(4)$ = 33.91, p = .011, characterized by both linear, $\chi^2(1)$ = 17.31, B = .66, SE = .16, p < .001, and quadratic, $\chi^2(1)$ = 12.20, B = .42, SE = .12, p < .001, growth. Basically, attachment avoidance stayed unchanged from age of 10 to 12 years but increased steeply from age 12 to 14 years. Furthermore, child's age predicted EC, $\chi^2(1)$ = 11.23, p = .024, such that EC was lower at the age of 10 years compared to the ages of 11 years, diff = > −0.09, SE = .04, p = .034, and 12 years, diff = > −0.15, SE = .05, p = .005. Child's age or the covariates did not predict attachment anxiety or brooding.

Effects of attachment and EC on brooding

Regarding our research question about the effects of attachment and EC on brooding, the results showed that attachment avoidance and EC interacted to predict brooding, χ^2 (1) = 8.10, B = 0.06, SE = .03, p = .025, and also the main effect of attachment avoidance predicted brooding, $\chi^2(1)$ = 7.66, B = 0.02, SE = .03, p = .025. The interaction is visualized in Figure 1. RoS analysis yielded that the EC significantly predicted brooding only among children with low avoidance (z-score ≤ −1.27, i.e. lowest 10.20%ile) and that avoidance significantly predicted brooding only among children with high EC (z-score ≥ 0.82, i.e. highest 20.75%ile). These results concur with our dual-benefit hypothesis, as children who had both low attachment avoidance (i.e. high attachment security) and high EC experienced low brooding. However, these results were against our cognitive deactivation hypotheses, as EC did not significantly predict brooding among children with high attachment avoidance. There was no three-way interaction between avoidance, EC and child's age, $\chi^2(4)$ = 4.24, p = .350, to predict brooding.

There was also a main effect of attachment anxiety predicting brooding, $\chi^2(1)$ = 5.11, p = .040. Parameter estimates indicated that higher attachment anxiety predicted higher brooding, B = 0.08, SE = .03, p = .009. Yet, there was no significant interaction between attachment anxiety and EC, $\chi^2(1)$ = 1.54, p = .258, nor a three-way interaction between anxiety, EC and child's age, $\chi^2(4)$ = 5.16, p = .285, on brooding. Altogether, these results concur with our brooding hyperactivation hypothesis, as anxiously attached children brooded irrespective of their EC. However, these results were against our dual-benefit hypothesis, as EC did not significantly predict brooding among children with low attachment anxiety.

Table 1. Descriptive values and Pearson correlations between the main study variables at T1, T2, and T3.

		M	SD	Sex T1	Educ T1	Age T1	Attachment Anxiety T1	T2	T3	Attachment Avoidance T1	T2	T3	Effortful Control T1	T2	T3	Brooding T1	T2	T3
Child's sex	T1	1.52	0.50	1.00	-.07	.11	.02	-.10	-.08	-.16	-.18*	-.06	.14	.17*	.20*	.02	.06	.15
Education	T1	2.74	0.39	-.07	1.00	-.08	.03	-.04	.11	.09	.08	.15	.26**	.21*	.19*	-.12	-.02	-.01
Age (years)	T1	10.91	0.87	.11	-.08	1.00	.08	-.06	.12	.04	.17*	.27**	.10	.02	.06	.22**	.13	.19*
Attachment Anxiety	T1	1.49	0.71	.02	.03	.08	1.00	.56**	.56**	.43**	.33**	.32**	-.10	-.15	-.20*	.24**	.18*	.30**
	T2	1.43	0.65	-.10	-.04	-.06	.56**	1.00	.56**	.32**	.37**	.28**	-.14	-.20*	-.19*	.26**	.32**	.30**
	T3	1.42	0.63	-.08	.11	.12	.56**	.56**	1.00	.24**	.34**	.46**	-.16	-.20*	-.27**	.25**	.19*	.39**
Attachment Avoidance	T1	2.81	1.16	-.16	.09	.04	.43**	.32**	.24**	1.00	.52**	.39**	-.03	-.01	-.07	.11	.15	.09
	T2	2.99	1.13	-.18*	.08	.17*	.34**	.37**	.34**	.52**	1.00	.59**	-.01	-.13	-.13	.24**	.31**	.18*
	T3	3.19	1.28	-.06	.15	.27**	.32**	.28**	.46**	.40**	.59**	1.00	-.07	-.13	-.15	.19*	.13	.27**
Effortful Control	T1	3.44	0.60	.14	.26**	.10	-.10	-.14	-.16	-.03	-.01	-.07	1.00	.84**	.75**	.03	-.05	-.06
	T2	3.41	0.61	.17*	.21*	.02	-.15	-.20*	-.20*	-.08	-.13	-.13	.84**	1.00	.82**	-.04	-.14	-.13
	T3	3.42	0.65	.20*	.19*	.06	-.20*	-.19*	-.27**	-.10	-.16	-.15	.75**	.82**	1.00	-.04	-.03	-.09
Brooding	T1	2.04	0.68	.02	-.12	.22**	.24**	.26**	.25**	.11	.24**	.19*	.03	-.04	-.04	1.00	.50**	.40**
	T2	2.04	0.67	.06	-.02	.13	.18*	.32**	.19*	.15	.31**	.13	-.05	-.14	-.03	.50**	1.00	.45**
	T3	1.98	0.67	.15	-.01	.19*	.30**	.30**	.39**	.09	.18*	.27**	-.06	-.13	-.09	.40**	.45**	1.00

Education refers to parental education level. Child's sex values: 1 = boy, 2 = girl. Datapoints range from n = 124 to n = 157.
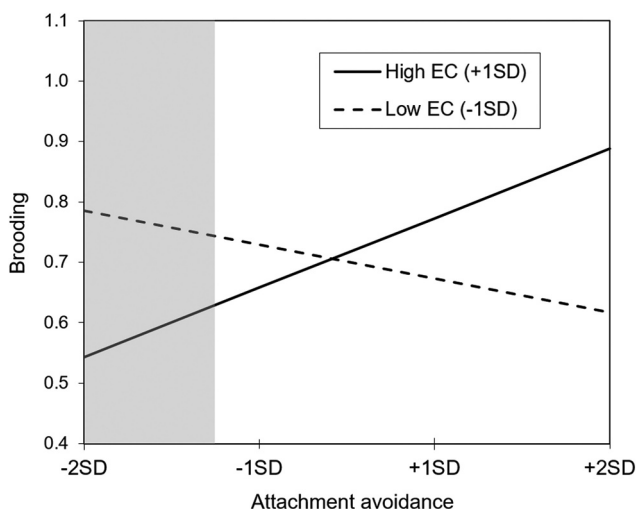
Figure 1. Interaction between attachment avoidance and effortful control (EC) predicting brooding. Shaded portion indicates the area of attachment avoidance (z-score ≤ -1.27) in which EC had a significant effect ($p < .05$) on brooding. The higher boundary value for the area was outside of the empirical range (z-score ≥ 2.42, i.e. highest 0.78%ile) and is thus not drawn.

Finally, EC and child's age interacted to predict brooding, $\chi^2(1) = 12.08$, $p = .048$. The interaction is visualized in Figure 2. Post hoc analyses indicated that low EC was more strongly associated with high brooding at age of 14 years compared to the younger ages of 10 years, $B = -0.24$, $SE = .08$, $p = .002$; 11 years, $B = -0.16$, $SE = .07$, $p = .025$; and 12 years, $B = -0.19$, $SE = .08$, $p = .014$. The association was also stronger at the age of 13 years compared to 10 years, $B = -0.12$, $SE = .04$, $p = .006$. In other words, the significance of EC on brooding increased as the children grew older, being nonsignificant between the ages
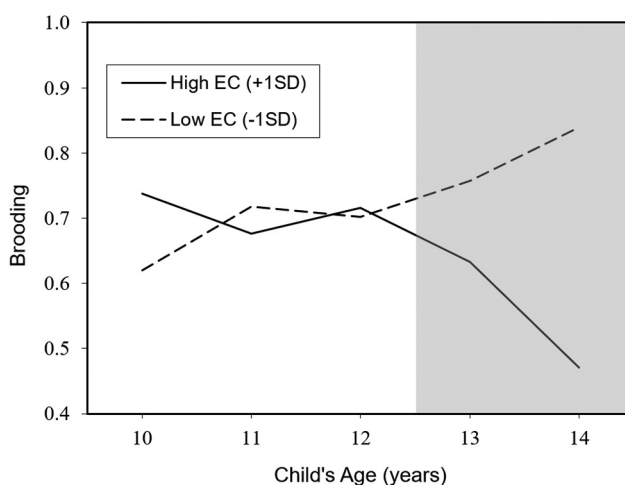

Figure 2. Interaction between effortful control (EC) and child's age in predicting brooding. Shaded portion indicates the area of Child's Age (>12 years) in which EC has significant effect on brooding.

of 10 and 12 years, $B = 0.18$, $SE = .02$, $p = .449$, but significant between the ages of 13 and 14 years, $B = -0.07$, $SE = .03$, $p = .034$. These results concur with our hypothesis that the role of EC on brooding becomes more important as the children grow older.

Additional analyses on EC subdimensions

In additional analyses, we tested whether attachment and EC subdimensions, involving inhibitory control (INH), attention control (ATT) and activation control (ACT), predicted brooding. These explorative results are presented in detail in the Appendix. In general, the results focusing on INH and ATT mirrored those of our main results. An exception to this was a new three-way interaction between ATT, attachment anxiety and child's age. Post hoc analyses indicated that children who had both high attachment anxiety and low ATT experienced high brooding irrespective of age. Yet, among the 10-year-old children low ATT in combination with low attachment anxiety (i.e. high attachment security) predicted low brooding, whereas among the 14-year-old children high ATT in combination with high attachment anxiety predicted low brooding. Finally, ACT did not predict children's brooding at all. Altogether, the additional analyses suggest that ATT may have age-dependent role on brooding with attachment anxiety, and INH and ATT seem to be more important predictors of brooding than ACT.

Discussion

Brooding is a maladaptive form of emotion regulation and confers a transdiagnostic risk for various forms of psychopathology. The primary aim of the present study was to test how parent-child attachment and EC interact to shape brooding among children during the developmental transition from middle childhood to early adolescence. First, in line with the dual-benefit hypothesis, we found that less avoidantly attached children with higher EC displayed less brooding. Surprisingly, against our hypothesis, we did not find support for this hypothesis for less anxiously attached children. Moreover, as expected, we found that the importance of EC on brooding increased as children grew older. However, child's age did not moderate any interaction effects of attachment and EC on brooding.

In the current study, we found an attachment × EC interaction effect for attachment avoidance. The interaction effect means that only children who more likely to seek comfort from their mother during distress display more or less brooding depending on their EC capacity. Specifically, we found support for the dual-benefit hypothesis, such that children with high EC capacity and low scores on attachment avoidance show the lowest levels of brooding. This pattern of results corresponds with Hilt et al. (2012) who, instead of children's attachment, focused on the quality of parenting. The study found a similar dual-benefit effect in terms of low over-controlling parenting predicting child's low brooding only if the child had high EC. In keeping with the expected association between parenting and attachment (Jones et al., 2015), our study extends their findings to the child's attachment.

However, the beneficial effect occurred only for avoidant, but not for anxious attachment. The reason for this is unclear, but may reflect the way the dimensions are assessed in ECR-R (Fraley et al., 2000). The avoidance dimension involves items referring to both active avoidance and secure based support seeking (reverse scored). In contrast, the

anxious dimension is more unidimensional and does not involve explicit secure behaviors (i.e. all items refer to preoccupation with rejection). Thus, the avoidance dimension may be more sensitive to capture the protective effects of secure attachment against brooding. In addition, it has been suggested that different attachment functions of the attachment system vary in their cognitive complexity. For example, organizing secure based social support seeking may be cognitively more demanding process than anxious threat monitoring (Fraley & Shaver, 2000). Our results support the view that cognitive resources are especially beneficial for implementing security based strategies, typically involving social support seeking and flexible emotion regulation (Long et al., 2020).

Against our cognitive deactivation hypothesis, high EC did not predict low brooding among avoidantly attached children. This was surprising, as previous experimental studies have found many avoidant strategies to depend on one's cognitive resources (Chun et al., 2015; Kohn et al., 2012). The discrepancy between the results of these previous studies and our null results may relate to different levels of focus. While the experimental studies have focused on moment-by-moment processes, we have focused on more long-term changes and development. Thus, it is possible that while high EC help enact avoidant defenses in some occasions, it may not protect against the developmental effects of avoidance on brooding. Indeed, attachment avoidance has been found to associate with brooding tendencies through trait-level difficulties in understanding and regulating own emotions (Lanciano et al., 2012). Further, it is possible that the assessment of emotion regulation strategies more relevant for attachment avoidance (e.g. denial and expressive suppression) could have provided different picture about the interplay between avoidant attachment and EC on emotional functioning.

In line with our brooding hyperactivation hypothesis, we found a main effect of attachment anxiety indicating that higher anxiety predicted higher brooding. This aligns with previous research showing that attachment anxiety is a robust predictor of brooding, yet, extends it by showing the effect to occur irrespective of children's EC. One plausible explanation for our result concerns the alignment of brooding with the regulatory goals of anxiously attached children. Brooding heightens the child's negative affect, a hyperactivation strategy developed to draw inconsistently available attachment figures' attention (Cassidy, 2016). So, if more anxiously attached children automatically respond to stress by brooding, and if this aligns with their longer term goals, they do not need EC capacity to suppress brooding. Alternatively, it is possible that the activation of attachment-related worries (e.g. about rejection) disrupt cognitive self-regulation. This could, regardless of child's typical EC capacity, lead to brooding. Further studies are needed to scrutinize which processes link attachment anxiety and brooding, involving, for example, implicit beliefs about emotion regulation goals and interference effects of negative emotions.

Yet, it would be premature to conclude from the current study that there are no interactions between anxious attachment and any cognitive processes explaining brooding. Post-hoc additional analyses hinted that efficient attention control, one subdimension of EC, seem to help anxiously attached children limit their brooding as they grow older. Moreover, our main results show that EC became increasingly important predictor of brooding among the older children. Altogether, these age-related effects align with Snyder et al. (2019) and suggest that as children become more autonomous in their emotional regulation, the significance of their self-regulation skills on brooding increases. In this context, it was highly

interesting to find that the attentional control could counteract anxiously attached children's tendency to brood. This could be clinically very relevant, as it suggests that anxiously attached children approaching adolescence could benefit from attentional control training to reduce their vulnerability to brood. Further studies are needed to replicate our findings in larger samples with greater focus on the more narrow subdimensions of EC.

Our results resonate with dual-process models that acknowledge thought processes to occur at both explicit and implicit levels (Carver & Johnson, 2018; Evans, 2011). Within this framework the EC is seen as a top-down control system, and the attachment as a more reflexively functioning system. Our findings suggest that these systems operate both synergistically and independently of each other. The synergistic benefit on emotional well-being (i.e. low brooding) may result from a process in which cognitive resources foster the implementation of secure based strategies (e.g. actual and/or imagined support seeking). In line with this, neuroimaging research has shown securely attached individuals to have better neural connectivity between their cognitive control system (responsible for emotion regulation and mentalization) and aversion module (responsible for fight-or-flight responses and threat detection) (Long et al., 2020). This may allow securely attached individuals to integrate and coordinate their explicit and implicit regulatory goals that results in added benefits on their emotional well-being. Our findings suggest that children with insecure attachment do not benefit similarly from their cognitive self-regulatory capacity. This is not self-evident, as efficient top-down control system could have been expected to outweigh some aversive responses generated by the insecure attachment system. Yet, as demonstrated by experimental studies (e.g. Sakman & Sümer, 2018), the activation of attachment insecurity can hijack and interfere with cognitive and attentional functions, with potential detrimental effects on emotional well-being.

Strengths and limitations

Strengths of our study involve a three-wave longitudinal sample that allowed us to consider developmental dynamics during the transition to adolescence. Our focus on the interplay between attachment and EC was novel and provided new information about the processes underlying brooding. We utilized both mothers and children as informants and thereby lessened the risk of shared method bias. We adequately controlled for the number of statistical tests to avoid false-positive findings. Finally, in additional analyses, we focused on subdimensions of EC to confirm the robustness of our main findings.

Despite these strengths, our study also has several conceptual and methodological limitations. First, we focused on the concurrent age-specific effects of EC and attachment on brooding. Thus, caution is warranted regarding causal interpretations of our results. For example, it is possible that children's brooding, together with their attachment, influences their EC (rather than vice versa). Experimental intervention studies (e.g. on attachment therapy and/or cognitive remediation) are needed to evaluate the causal nature of the observed associations. Second, we did not consider mediated processes that could occur between EC and attachment. There is some evidence that insecure attachment predicts low EC that further predicts emotional maladjustment (Heylen et al., 2017). However, in line with previous research (Pallini et al., 2018), our data showed very small correlations between attachment and EC, providing no indication of such mediated process. Despite this, we encourage future studies to consider the co-occurrence of

both moderation and mediation effects and to test different mechanisms for the attachment dimensions (e.g. interaction for avoidance and mediation for anxiety). Third, our data was based on questionnaires and may have thus been biased by various self-reporter biases. While the ECR-RC is a cost-effective way to assess the two dimensions of attachment, it emphasizes conscious perceptions and is thus vulnerable for defensive distortions. Therefore, further studies are needed to test the replicability of our findings, preferably utilizing both self-report and interview methods to assess attachment, and to also utilize behavioral assessments of cognitive self-regulation capacity (i.e. executive control). Finally, we assessed child's attachment towards the mother but not towards the fathers. Even while adolescent's attachment towards both parents tend to correlate (Brenning et al., 2011; Flykt et al., 2021), there is some evidence on both the primacy of maternal attachment and on the joint effect of the maternal and paternal attachments on adolescent's emotional well-being (Rivers et al., 2022). Thus, in future research, it will be important to evaluate the potential unique and interactive effects of mother and father-related attachment on children's brooding.

Conclusions

Our novel study confirmed the significance of both parent-child attachment and EC on children's brooding rumination. We found an interaction between avoidant attachment and EC: more securely attached children (i.e. low avoidance) benefitted from high EC in terms of low brooding, whereas more insecurely attached children did not. Instead, anxious attachment was linked to brooding irrespective of EC. These associations remained stable during the transition to adolescence, suggesting no developmental changes in the dynamics between attachment and EC within this age period (i.e. from 10 to 14 years). At the same time, it was apparent that the children transitioned towards greater autonomy during this period, as their attachment avoidance towards their mother increased and the importance of EC on own emotional well-being increased. Clinically, it may be beneficial to tailor individual interventions based on whether child's excessive brooding is driven by attachment insecurity, self-regulatory deficits, or both. Theoretically, our findings demonstrate that the attachment and cognitive self-regulatory systems are functionally related. Further research is needed to replicate our findings and to chart the areas in which these social and cognitive domains interact to predict development and behavior.

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APPENDICES

APPENDIX A

Table A1. Detailed description of the main GEE model predicting brooding.

	Effect		FDR correction	
	Wald Chi-Square	Uncorrected p-value	Relevant for RQ?	Corrected p-value (q)
(Intercept)	975.06	.000***	No	
Age	1.28	.865	No	
Sex	4.47	.034*	No	
Family Education	0.73	.392	No	
EC	3.95	.047*	Yes	.079
Anxiety	5.11	.024*	Yes	.050*
Avoidance	7.66	.006**	Yes	.025*
Age × Sex	8.09	.088	No	
Age × Family Education	8.31	.081	No	
Age × EC	12.08	.017*	Yes	.048*
Age × Anxiety	3.51	.477	Yes	.258
Age × Avoidance	6.63	.157	Yes	.220
Age × Family Education	0.66	.417	No	
Sex × EC	0.65	.420	No	
Sex × Anxiety	3.92	.048*	No	
Sex × Avoidance	2.92	.088	No	
Family Education × EC	0.48	.487	No	
Family Education × Anxiety	4.45	.035*	No	
Family Education × Avoidance	0.36	.551	No	
EC × Anxiety	1.54	.215	Yes	.258
EC × Avoidance	8.10	.004**	Yes	.025*
Age × EC × Anxiety	5.16	.271	Yes	.285
Age × EC × Avoidance	4.24	.375	Yes	.350

RQ : Research Question. False Discovery Rate (FDR) correction is based on two-stage sharpened method (Benjamini et al., 2006). Overall fit indices for the GEE model were QIC = 117.96 and QICC = 130.04. * $p < .05$, ** $p < .01$, *** $p < .001$.

APPENDIX B Additional analyses of effortful control subdimensions

This appendix presents additional analysis testing the joint effects of attachment and effortful control (EC) subdimensions on brooding, with focus on inhibitory control (INH), attentional control (ATT), and activation control (ACT). We considered these analyses exploratory as we had no a priori hypotheses regarding the differential effects of these subdimensions. The models were identical with the main GEE model (e.g. involved the same covariates), but instead of the total score (EC) the subscale scores (INH, ATT, or ACT) were used. As in the main analyses, the focus was on the main and interaction effects of attachment and the EC subdimensions to predict brooding. False discovery rate (FDR) correction based on two-stage sharpened method (Benjamini et al., 2006) was used to control for multiple statistical test in each model (i.e. 10 p-values).

Effects of attachment and inhibitory control on brooding

There was an interaction between INH and attachment avoidance to predict brooding, $\chi^2(1) = 6.69$, $B = 0.06$, $SE = .03$, $p = .025$. Similarly as in the main results (see Figure 1), RoS analysis yielded that INH had significantly predicted brooding among children low in attachment avoidance (z-score ≤ -1.26, i.e. lowest 10.39%ile) and avoidance predicted brooding among children relatively high in INH (z-score ≥ 0.72, i.e. highest 25.58%ile). Furthermore, there was a main effect of attachment anxiety predicting brooding, $\chi^2(1) = 5.11$, $p = .040$, such that higher attachment anxiety predicted higher brooding, $B = 0.07$, $SE = .03$, $p = .007$. Finally, INH and child's age interacted to predict brooding, $\chi^2(1) = 11.01$, $p = .040$.

Similarly as in the main results (see Figure 2), post hoc analyses indicated that low INH was more strongly associated with high brooding at age of 14 years compared to the younger ages of 10 years, $B = -0.22$, $SE = .09$, $p = .033$, and to 11 years, $B = -0.16$, $SE = .06$, $p = .005$. The association was also stronger at the age of 13 years compared to 10 years, $B = -0.10$, $SE = .05$, $p = .030$, and to 11 years, $B = -0.07$, $SE = .04$, $p = .039$. In other words, the significance of INH on brooding increased as the children grew older, being nonsignificant between the ages of 10 and 12 years, $B = -0.01$, $SE = .03$, $p = .678$, but significant between the ages of 13 and 14 years, $B = -0.10$, $SE = .04$, $p = .010$.

Effects of attachment and attentional control on brooding

There was an interaction between ATT and attachment avoidance predicting brooding, $\chi^2(1) = 7.08$, $B = 0.06$, $SE = .03$, $p = .009$. Similarly as in the main results for EC (see Figure 1), RoS analysis yielded that ATT significantly predicted brooding among children low in attachment avoidance (z-score ≤ -1.27, i.e. lowest 10.20%ile) and avoidance significantly predicted brooding among children relatively high in ATT (z-score ≥ 0.50, i.e. highest 30.85%ile). Interestingly, different from the main results there was a three-way interaction between ATT, attachment anxiety and child's age to predict brooding, $\chi^2(4) = 13.53$, $p = .009$. This three-way interaction is visualized in Figure A1. Post hoc analyses yielded that interaction between ATT and anxiety was significant among the youngest 10-year-old children, $\chi^2 = 3.83$, B $= > -0.10$, $SE = .04$, $p = .006$, and among the oldest 14-year-old children, $\chi^2 = 9.44$, $B = -0.16$, $SE = .05$, $p = .002$. In contrast, among children between the age of 11 and 13 years there was only a main effect of attachment anxiety predicting brooding, $\chi^2 = 13.10$, $B = .08$, $SE = .03$, p < .001, but no main effect of ATT, $\chi^2 = 0.81$, $B = .01$, $SE = .03$, $p = .367$, or interaction between ATT and anxiety, $\chi^2 = .01$, $B = -.01$, $SE = .03$, $p = .973$, to predict brooding. Thus, RoS analyses were run separately for the youngest 10-year-old and oldest 14-year-old children.

Among the 10-year-old children, ATT significant predicted brooding among children low in attachment anxiety (z-score ≤ -0.49, i.e. lowest 31.21%ile) and among children high in attachment anxiety (z-score ≥ 1.29, i.e. highest 9.85%ile). Furthermore, attachment anxiety significantly predicted brooding only among children low in ATT (z-score ≤ -0.57, lowest 28.43%ile). In other words, as shown in Figure A1, among children with low attachment anxiety (i.e. secure attachment) low ATT predicted low brooding. In contrast, among children with high attachment anxiety low ATT predicted high brooding.

Among the 14-year-old children, ATT significantly predicted brooding among most children (z-score ≥ -1.58, i.e. highest 94.30%ile), excluding only those very low in attachment anxiety (i.e. secure attachment). Furthermore, attachment anxiety significantly predicted brooding among children high in ATT (z-score ≥ 0.12, i.e. highest 45.22%ile). In other words, as shown in Figure A1, most children with low ATT experienced high brooding irrespective of their attachment anxiety. In addition, among children with high ATT, high attachment anxiety predicted especially low brooding.

Effects of attachment and ACT on brooding

Somewhat unexpectedly, the model involving ACT showed only a main effect of avoidance to predict brooding, $\chi^2(1) = 8.58$, $p = .028$, such that higher attachment avoidance predicted higher brooding, $B = 0.05$, $SE = .02$, $p = .010$. It is noteworthy that with more relaxed criterion (i.e. without the FDR corrections) the main effect was significant for attachment anxiety, $\chi^2(1) = 85.63$, $p = .018$, but still clearly not for ACT, $\chi^2(1) = 0.01$, $p = .980$. Altogether, these results indicate that the ACT subdimensions did not predict brooding, either alone or in combination with attachment.

Conclusions from the additional analyses

The additional analyses revealed that the main results regarding EC and attachment on brooding were most likely driven by the subdimensions of inhibitory control (INH) and attention control (ATT) but not by activation control (ACT). This is in line with recent developmental research

suggesting that ATT and INH reflect children's cognitive executive function, whereas ACT may reflect broader behavioral tendencies (Kim-Spoon et al., 2019; Zhou et al., 2012). Thus, ATT and INH may be most relevant for brooding, which is inherently a mental process. Importantly, however, the overall pattern of results for ATT and INH was in line with the main results, indicating that the main findings are relatively robust against the variation of the used subscales. An exception was, however, the appearance of complex interaction effect between attachment anxiety, ATT and child's age. As the additional analyses were exploratory, these results should be viewed cautiously and wait for further replication. Yet, we hope they encourage researchers to further test which specific cognitive processes interact with attachment to shape regulatory processes.

The novel finding involving the interaction between attachment anxiety, ATT and age extends our main results. First, the result suggests that children who have both high attachment anxiety and low ATT are at "double risk" for high brooding, both at the age of 10 and 14 years. This is in line with previous studies showing separately, that attachment anxiety (Van de Walle et al., 2016) and low attention control (Shaw et al., 2019) associates with brooding. Importantly, the significance of the other combinations of attachment anxiety and ATT on brooding seemed to be highly dependent on child's age.

Among the 10-year-old children, low ATT in the context of low attachment anxiety (i.e. attachment security) predicted especially low brooding. While this was somewhat unexpected, it can be speculated to emerge from age salient cognitive and social processes. First, low ATT may indicate high attentional fluidity, which in the context of secure attachment (i.e. no need to worry about parental rejection) could counteract brooding tendencies. Second, parents of children with secure attachment may respond supportively to their child's low ATT, for example by providing emotional scaffolding, which could result in low brooding at this age. Our results indicate, however, that the benefits of low ATT on brooding diminish as the children grow older, perhaps indicating children's difficulties to respond to the expectations and demands of more autonomous self-regulation as they approach adolescence.

Among the 14-year-old most children with low ATT experienced high brooding. Interestingly, however, children with high attachment anxiety (rather than children with low attachment anxiety) seemed to benefit from high ATT in terms of especially low brooding. This is somewhat surprising, as the association between high attachment anxiety and rumination is considered to be robust. Our findings suggest, however, that those anxiously attached children who have high cognitive capacity may learn to suppress rumination during their development from middle childhood to early adolescence. Further studies are needed, however, to more strictly test the hypothesis that ATT modulates the development of brooding among highly anxious children and adolescents.
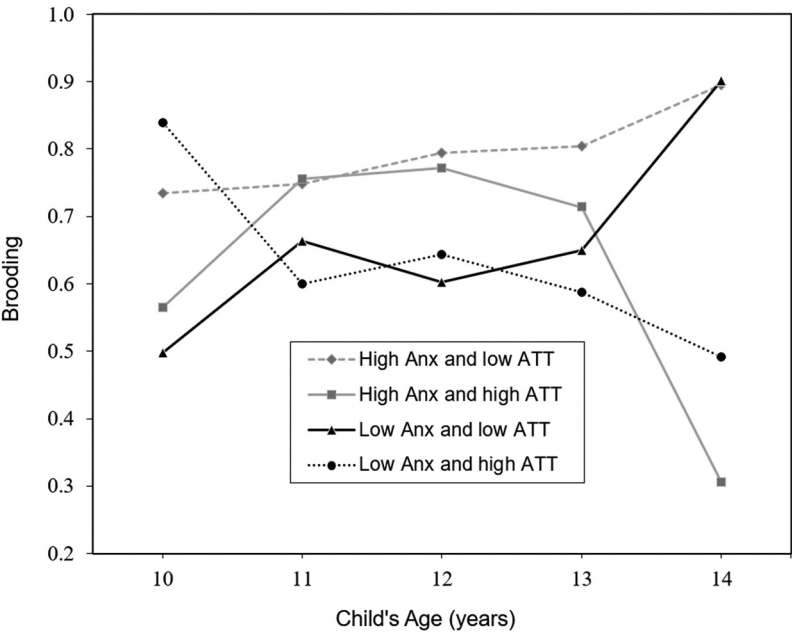
Figure A1. Three-Way interaction between children's attentional control, attachment anxiety, and age predicting brooding. Anx: Attachment anxiety. ATT: Attentional control. High and low values refer to +1SD and -1SD, respectively.