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The Effect of Attachment Priming on State Attachment Security in Middle Childhood: The Moderating Roles of Trait Attachment and State Attachment Volatility

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Abstract

Recent studies showed that attachment security can change within persons, suggesting that there might be an interplay between a rather stable (trait) and rather variable (state) part of attachment. The study's first aim was to investigate whether attachment priming could influence the level of state attachment. The second aim was to explore possible moderators explaining individual differences in the relation between state attachment responses to

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attachment versus neutral primes. This can shed light on individual differences in attachment prime-induced state attachment. We conducted a within-subjects priming study in which children (9–13 years) were allocated to three priming procedures (neutral, secure, avoidant). Results showed an increase in secure state attachment after secure attachment priming. Individual differences in the strength of this effect were moderated by trait attachment and state attachment volatility. First findings cautiously suggest that state attachment security can change in response to environmental cues under certain circumstances.

Keywords
attachment, family relations/processes, developmental processes, parent-adolescent relationships

Attachment security or insecurity (further referred to as attachment security) has mostly been approached as a rather stable phenomenon (Fraley, 2002), but several studies have suggested that attachment security substantially varies within subjects over time (Groh et al., 2014). One developmental period during which attachment quality may substantially change is middle childhood, but the processes that explain attachment variability in this age-group remain little understood (Waters et al., 2019). Some studies suggest that attachment consists of trait-like and state-like components that interact in explaining state attachment changes over time (Bosmans, Bowles, et al., 2014; Verhees et al., 2019). State attachment security refers to a dynamic component reflecting the level of trust (or secure attachment) in attachment figures' availability to provide support during distress at a specific moment in time. Trait attachment security refers to children's general level of trust in attachment figures' availability (or secure attachment) that is relatively stable over time. Some literature therefore talks about dispositional attachment (Ein-Dor & Hirschberger, 2016; Shaver et al., 2016). However, we will refer to it as trait attachment to keep in line with similar research on attachment dynamics (Bernaerts et al., 2017; Bohn et al., 2021; Chenglong et al., 2020; Verhees et al., 2021).

State attachment security has been found to fluctuate contingent upon the quality of ongoing interactions with parents (Vandevivere et al., 2018) and, in adults, state attachment security changed when attachment memories were primed by activating secure or insecure attachment memories (Gillath et al., 2009). It remains unclear whether such priming effects on state attachment security can also be found in children. Therefore, the current study investigated whether attachment security states can be primed in middle childhood children. Moreover, we explored moderators of this priming effect, testing

whether trait attachment security and state attachment volatility moderated individual differences in the stability of state attachment in response to neutral versus attachment priming. A better understanding of what processes can determine children's levels of stability or variability in state attachment could move the theory on attachment development significantly forward and inform attachment-focused therapy in this age-group (e.g., Bosmans et al., 2022).

Although Bowlby (1969) considered attachment security to have the potential to change over time, he also assumed that attachment-related expectations, once developed, remain rather stable in quality. Secure and insecure attachments would lead to stable expectations about parental availability (a trait-like attachment component), that however can be updated by new information (Waters et al., 2019). The state-like attachment component can fluctuate from moment to moment in response to contextual information and repeated states may evolve into more stable trait-like attachment expectations over time. This suggests that understanding variability at the trait attachment level requires studying processes explaining differences at the state attachment level.

Children's in-the-moment appraisals of their attachment figures' availability (secure state attachment), of their fear for their attachment figures' rejection (anxious state attachment), and of their inclination to avoid support seeking (avoidant state attachment) may vary substantially from moment to moment (Bosmans, Van de Walle, et al., 2014). Bosmans et al. (2020) proposed two processes that affect state attachment volatility. First, state attachment security gets activated during real time care-related experiences and, over learning trials, feeds into (lack of) secure trait attachment and Secure Base Script knowledge. Indeed, secure state attachment seems to increase when children receive secure base support (Vandevivere et al., 2018). In contrast, secure state attachment decreases when children experience no support during distress (Vandevivere et al., 2018), or when they experience conflict with attachment figures (Bosmans, Van de Walle, et al., 2014). Second, state attachment security levels can differ when specific attachment-related memories are activated (Hudson & Fraley, 2018). According to Bosmans et al. (2020), positive and negative attachment-related learning experiences get stored in memories. Children who are more securely attached at trait-level have better access to positive attachment-related memories, while children who are more insecurely attached at trait-level have better access to negative attachment-related memories (Dujardin et al., 2014). However, in keeping with learning research (Bouton, 2000), it is reasonable to assume that trait attachment incongruent memories are deactivated rather than erased and can get reactivated when exposed to stimuli that prompt memory recollection which subsequently becomes a source of state attachment fluctuations (Bosmans et al., 2020).

The latter phenomenon is typically studied with priming paradigms in which individuals are exposed to stimuli aimed at reactivating emotional states and appraisals (e.g., Janiszewski & Wyer, 2014). Attachment (in)security priming research (activating positive or negative memories about attachment figures) has mostly been done in adults and has shown short-term changes in perceived relationship quality and state attachment after attachment priming (Bosmans, Bowles, et al., 2014; Carnelley & Rowe, 2007). Attachment (in)security priming research in children is limited, but existing research confirms the impact of attachment primes on children's emotional states (Stupica et al., 2019; Rowe et al., 2020). Hence, it seems plausible that, like in adults, attachment primes would affect children's state secure attachment levels.

Moreover, adult priming research has shown that there are important individual differences in the extent to which the attachment prime affects attachment states (Rowe et al., 2020). Similarly, we expect that some children will show equally high or low state attachment levels after a neutral prime or an attachment prime, whereas other children's state attachment levels change after attachment primes compared to their state attachment level after the neutral primes. This raises the question which factors are linked to these individual differences in attachment prime effect. We will shed light on this question by investigating whether the association between state attachment after the neutral prime and after attachment primes is different depending on children's level of trait attachment and depending on children's level of state attachment volatility.

With regard to the moderating effect of trait attachment on individual differences in the relation between state attachment responses to attachment priming versus state attachment responses to neutral priming, theory suggests a trade-off could between trait and state attachment security influencing attachment priming effects (Bosmans et al., 2020; Rowe et al., 2020). This trade-off hypothesis was based on the observation that trait attachment is characterized by biases in children's processing of attachment-related information, such that information congruent with trait attachment expectations is processed more easily at the expense of incongruent information (Dykas & Cassidy, 2011; Zimmermann & Iwanski, 2015). This would imply for the current study that depending on the level of secure trait attachment, children's state attachment levels would differ more or less in response to attachment primes. In middle childhood, Bosmans, Van de Walle, et al. (2014) found support for this trade-off hypothesis during daily interactions between children and their mother, showing that conflict with mother less likely reduced children's secure state attachment when they were more securely attached at trait level. It could be that state attachment experiences during ongoing interactions (i.e., what children experience while they interact with their parents) tap into different processes than state attachment changes that follow

activating memories about past interactions with parents. Nevertheless, these findings do suggest that children with higher levels of trait attachment might be characterized by a higher intercept and a smaller slope since their state attachment will already be high after the neutral prime leaving no room for an increase, whereas children with lower trait levels will have a lower intercept and a stronger slope, demonstrating the positive effect of the attachment prime.

Concerning the moderating role of trait attachment on individual differences in the relation between attachment and neutral priming effects, we explored this hypothesis using two indicators of secure trait attachment: self-reported trait trust in maternal support and secure base script knowledge. These two indicators can be considered two different components of the same underlying attachment construct (Steele, 2015). Self-reported trait attachment refers to children's explicit evaluation of their confidence in parental support. Secure base script knowledge refers to children's secure attachment knowledge about a chain of events that typically unfolds during a care-related interaction with attachment figures (Waters & Waters, 2006). Secure base script knowledge is considered to reflect a deeper and more implicit level of attachment learning than self-reported secure trait attachment which is more explicit (Bosmans et al., 2020). Both components of the complex attachment construct thus tap into specific processes with more strategic processes underlying self-reported trait attachment and more automatic processes underlying secure base script knowledge (Bosmans & Kerns, 2015). So, testing the moderation hypothesis might be done for both components of secure trait attachment.

With regard to the moderating role of state attachment volatility on individual differences in the relation between state attachment responses to attachment priming versus state attachment responses to neutral priming, past attachment research has shown that children differ in the extent to which their state attachment security levels fluctuate in response to daily variations in the caregiving environment (Bakermans-Kranenburg & van IJzendoorn, 2007; Verhees et al., 2019). Higher state attachment volatility over days suggests that children respond more strongly to positive and negative information about their relationship with their attachment figure. Hence, it seems likely that more volatile children will respond more strongly to attachment primes as well, which was explored by testing whether attachment volatility determined the individual relation between attachment and neutral priming effects.

Current Study

In the current study we manipulated elementary school children's state attachment levels with three different priming conditions administered over the

course of 2 weeks in a within-subject design: a neutral prime, a secure attachment prime and an insecure attachment prime. For the secure attachment prime, we asked children to recall a memory in which they received effective help from their mother during distress. To prime insecure attachment, we opted to use an avoidant attachment prime in which children were asked to recall a memory in which they chose not to rely on maternal support during distress. We used an avoidant attachment style prime and not an anxious one as anxious attachment is characterized by high levels of rejection (Mikulincer et al., 2001). We deemed it unethical to subject children to thoughts of rejection. The study focused on children's attachment relationship to their mother, because in WEIRD countries during middle childhood she remains the main attachment figure, even though children's social world expands from family to peers as playmates (Brumariu & Kerns, 2008; Seibert & Kerns, 2009).

The study had two main aims. As a first aim, we investigated whether secure and insecure attachment priming can alter state attachment levels in middle childhood children (Q1). Based on research of Carnelley and Rowe (2007), we predicted that attachment security priming would lead to an increase in secure state attachment and a decrease in insecure state attachment. Inversely, we predicted that attachment avoidance priming would lead to a decrease in secure state attachment and an increase in insecure state attachment. As a second aim (Q2), we explored whether we can determine children's responsiveness to attachment primes at the state attachment level, (Q2a) based on their levels of trait attachment security (self-reported trait attachment and secure base script knowledge), and (Q2b) based on their levels of state attachment volatility.

Method

Participants

Fifty-six children were recruited from three schools in Flanders, Belgium. The response rate was 23.6%. To increase power to find small to medium effects (calculated a-priori with G-Power), we needed to increase the sample size and recruited six extra children outside of those schools through social media. For one participant, data collection was compromised resulting in a pattern of scores across the study that deviated significantly from the rest of the sample (e.g., the participant's state attachment slope's z-score was 6.081 with a probability that a child would display such a pattern of values $p < .00001$). Therefore, we imputed the deviating scores of this participant with the expectation-maximization method and included this data in all further analyses on 62 participants (40.3% boys) between 9 and 13 years old ($M = 10.72$, $SD = 0.92$). Sensitivity analyses showed that the findings replicated

independent of whether the analyses were conducted with the imputed values or with exclusion of the participant's data.

Most participants were of Belgian nationality (86.9%), 8.2% had a different nationality (4.9% Dutch, 1.6% Belgian-Dutch, 1.6% Syrian). The Syrian participant was not native Dutch speaking and struggled a bit with telling an autobiographical memory, but the data was of sufficient quality to include. The majority of mothers had a college education degree (73.8%), 16.4% of mothers had a secondary school degree and 4.9% had a primary school degree or no degree (4.9% missing). 80.3% of the participants lived with their biological family, 6.6% lived with one parent and 8.2% lived in a blended family. One participant lived in a foster family and two participants had missing data regarding their family composition. There is no strong evidence that the data are not missing complete at random (Little's MCAR test Chi-Square = 4.041, df = 5, p = .544).

Materials

State Attachment Security. We measured state attachment security with the State Attachment Questionnaire (SAQ, adapted from Bosmans, Bowles, et al., 2014). This questionnaire has 9 items measuring secure, anxious, and avoidant state attachment. Participants rated the applicability of every statement on a continuous scale (line of 11 cm) ranging from "not at all true" to "very true". An example item of the secure state attachment subscale is: "*at this moment, I feel that I'm important to my mother*". Cronbach's α for this scale was .94. An example item of the anxious state attachment subscale is: "*at this moment, I feel that if I would show my mother how much I love her, she won't love me as much*". Cronbach's α for the anxious state attachment subscale was .78. An example item of the avoidant state attachment subscale is: "*at this moment, I feel I would rather solve my problems alone*". However, Cronbach's α for the avoidant state attachment subscale was only .55. Due to this low internal consistency, the avoidant state attachment subscale was not included in further main analyses.

In addition to the State Attachment Questionnaire (SAQ), state attachment security was measured with the State Attachment Visual Analogue Scale (VAS) for further sensitivity analyses (see Supplementary file 1). This scale gauged the level of positive attachment related feelings at one point in time through 10 items. Participants rated on a continuous scale (line of 11 cm) how applicable a certain statement was for them, from 'not at all true' to 'very true'. The distance between the left of the line and their indication on the line represents the continuous score. An example item is: "*at this moment, I feel comforted*". The mean score over all 10 items reflects a measure of secure state

attachment. In the current sample, the VAS had a good internal consistency (Cronbach's α = .98).

Diary Data. State attachment volatility was assessed with a daily diary (Bosmans, Van de Walle, et al., 2014) in order to investigate volatility in state attachment in the 7 days before the secure priming procedure. During the 2 weeks that the experiment lasted, children were asked to complete an online diary at the end of every day. This diary assessed state attachment security every day with the SAQ. State attachment volatility was calculated for the SAQ by means of multi-level simultaneous component analysis (MLSCA, Timmerman, 2006; Ceulemans et al., 2016). This technique generates a within-participant component over time capturing the (in)variability of state attachment per participant. We calculated a state attachment volatility score based on the 9 items per day, in such a way that the differences across the days are maximally captured. We extracted only one within-participant component to be in line with previous research on state attachment volatility (Bosmans, Van de Walle, et al., 2014). This score allows volatility to differ across participants. We calculated the state attachment volatility score as the standard deviation of the within-component scores of state attachment security across the 7 days prior to the day that the children received the secure attachment prime, because we are interested in the level of susceptibility to changes in the environment prior to the prime as this could influence the experiment. More volatility is a signal of state attachment (in)security being less fixed while less volatility is a signal of a more fixed state attachment (in)security.

Trait Attachment Security. To measure trait attachment security levels in children, the Dutch version of the trust subscale of the People In My Life questionnaire was administered (PIML; Ridenour et al., 2006). This self-report scale consists of 10 statements gauging children's trust in their mother. Participants rated each statement on a 4-point Likert-scale ranging from 1 = "*almost never or never true*", to 4 = "*almost always or always true*". An example is: "*my mother accepts me for who I am*". A mean score was calculated over all 10 items, representing a level of secure trait attachment. Internal consistency was sufficient in the current study (Cronbach's α = .87). Previous research has indicated that the PIML shows some validity in measuring trait attachment security in middle childhood (Moreira et al., 2017; Ridenour et al., 2006).

Additionally, we used the Attachment Script Assessment (ASA; Waters & Waters, 2006) to capture trait attachment security in a different way. The ASA is an attachment related storytelling task that aims to measure knowledge about the Secure Base Script (SBS; Waters et al., 2015). On the basis of 12 word prompts, children were asked to tell a story. The most coherent storyline

was one in which the child experiences distress, the mother provides support and the child is able to go on with previous activities. The task is designed to measure children's knowledge of the SBS by means of how well children can tell a consistent and detailed story that fits with the SBS. During a school or home visit, the experimenter recorded the storytelling so the story could later be transcribed and coded. Waters and Waters (2006) created a scoring from 1 = "*poorly developed SBS knowledge*" to 7 = "*completely developed SBS knowledge*", based on the occurrence of six SBS elements in the story: (1) Constructive interaction, (2) a problem is occurring, (3) the child signals for help or proximity/the mother detects the need for help, (4) the mother provides effective help, (5) the problem is solved, and (6) child and mother are back on track engaging in constructive interaction again. First, under the supervision of the experimenter, the child did two practice stories with themes unrelated to attachment. Then, three sets of attachment related word prompts were presented and the child was asked to tell an as-if story pretending that it is happing at that point in time. The order of the three attachment-related stories was randomized over participants to avoid order effects. *All stories were coded together by two trained coders who came to a consensus score for every story. In previous research on a similar sample, the interrater reliability between these two coders was high, ranging from .80 to .97.* Internal consistency was sufficient in the current sample (Cronbach's α = .69).

Priming Procedure. Two different attachment primes were administered in a within-subjects multiple time point study, in counterbalanced order. We used a secure and an avoidant attachment prime, next to a neutral prime that functioned as a control prime, all presented to each participant. The primes and the priming procedure were piloted beforehand with different children of the same age and appeared clear and appropriate. During the first measurement timepoint, a neutral attachment-unrelated prime was presented in which children read a description of a watering can. Then, they were asked to describe a shovel in a similar way (see Appendix). This was done to control for mere priming effects on state attachment security. At the second session, after 1 week, children were exposed either to a secure attachment prime or an avoidant attachment prime. In both scenario's, children read a story about a child called Erik. In the secure attachment prime condition, the child was bullied at school and felt bad about it. Then, the child sought proximity to his mother who provided effective support to make the child feel better again (see Appendix). The reading of the story was deemed to stimulate recollection of similar autobiographical experiences (Baldwin et al., 1996). Then, children were asked to tell to the experimenter a similar autobiographical story in that moment, in which they experienced distress but support from their mother was helpful, to strengthen the priming effect. The avoidant

attachment prime was analogue to the secure attachment prime except that in the story the child did not share the distress and did not want help from the mother (see Appendix). Participants were then again asked to tell about a similar autobiographical experience in which they did not want mother's help.

Procedure

The current research aimed to study the effects of attachment priming on state attachment security in a within-subject design (see Appendix) and was approved by the Ethical Committee of KU Leuven (G-2018 12 1438). In total, there were four measurement points per participant, spread over three in-person timepoints during which measures were obtained at school or at home with an experimenter present (see Figure 1). The first day (timepoint 1) started with giving extended information about the study and signing the informed consent forms of both child and parent. This first measurement point was meant to capture baseline levels of trait attachment (in)security (PIML, SBS) and state attachment (in)security (SAQ) in counterbalanced order (measurement point 1). We also measured state attachment (in)security with a visual analogue scale (VAS) (see Supplementary file 1). Additionally, participants were exposed to the neutral prime, after which state attachment security was measured a second time (SAQ) (measurement point 2). This was done to control for effects resulting from just the priming procedure. From that moment onwards, the diary was sent to participants daily by email. After 1 week of completing diary data, during a second in-person timepoint (timepoint 2) children were presented with either the secure or avoidant attachment prime. After the prime, children filled out the SAQ again (measurement point 3). Another week of completing diary data later, children were exposed to either the avoidant or secure attachment prime respectively (timepoint 3). Afterwards, they completed the SAQ again (measurement point 4). Then, children and their mothers were debriefed and the child received a voucher of 40 euros as a reward for participation.

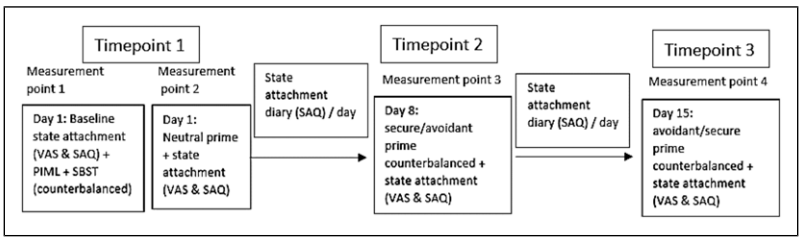

Figure 1. Within-participant design.

Statistical Analyses

Our first research question (Q1) whether attachment priming has immediate impact on state attachment security, was tested with repeated measures ANOVAs in SPSS (IBM Statistics, version 27). In the RM ANOVA, state attachment security measures at 4 timepoints were included as within-subjects variables (1 = baseline state attachment, 2 = state attachment after the neutral prime, 3 = state attachment after the secure attachment prime, 4 = state attachment after the avoidant attachment prime) and the priming order was set as a between-subjects variable. Two RM ANOVA's were conducted for the secure state attachment and anxious state attachment subscale of the SAQ. We corrected with Bonferroni to control for multiple testing ($\alpha = .025$). Because the avoidant state attachment scale was not sufficiently internally consistent, we did not include the analyses in the main results, but conducted the same analyses separately for each avoidant state attachment item. Results can be found in Supplementary file 3.

To explore our second research question (Q2), we conducted moderation analyses with the PROCESS macro in SPSS (Hayes, version 3.5.3, 2021). We investigated three possible moderators of the link between the independent variable secure state attachment (SAQ) after the neutral prime and the dependent variable of secure state attachment after the secure attachment prime: (1) self-reported trait attachment security, (2) SBS knowledge, and (3) state attachment volatility. We chose to compare the level of secure state attachment after the secure attachment prime to the level of secure state attachment after the neutral attachment prime instead of to the baseline level of secure state attachment because those two measures are more similar and standardized since both were administered after a priming procedure. To control for multiple testing, we applied the Bonferroni correction on all p-values ($\alpha = .017$). Additionally, to check whether our findings are robust, we redid the previous analyses with secure state attachment measured with the VAS scale. This sensitivity analysis and results can be found in Supplementary file 1.

Further, because priming effects might be affected by the extent to which children recalled an accurate attachment memory (Schacter et al., 2004), we performed a manipulation check to evaluate the accuracy of the reported autobiographical memories elicited by the primes. The autobiographical stories that children told were recorded and transcribed. We rated the memories on content accuracy of the memory, checking whether the memory was really secure or avoidant attachment-related in substance (0 = no, 1 = yes). Two raters coded all stories together to arrive at the given accuracy scores. Every participant without any reported memory after the prime was given a score 0. For the reported attachment memory accuracy, the accuracy was good for 94.9% of the secure attachment memories. Accuracy of the reported memories was lower after the avoidant prime, with only 75% of the

participants reporting an accurate, avoidant attachment memory. We conducted sensitivity analyses including only those children who reported an accurate autobiographical attachment memory after the secure and avoidant prime. Additionally, we examined the interaction between reported memory accuracy and secure state attachment levels, as well as the interaction with the moderators, to see whether reported memory accuracy affected the effectivity of attachment priming (see Supplementary files 2).

Results

Preliminary Analyses

In advance, we inspected the distribution of the data and their associations (see Table S1 in Appendix). Self-reported secure trait attachment was positively correlated with secure state attachment at baseline (SAQ + VAS). Also, SBS knowledge and secure state attachment at baseline measured with SAQ correlated positively with secure state attachment at baseline measured with VAS.

Research Question 1: Does Attachment Priming Alter State Attachment Security in Middle Childhood Children?

We found a main effect of time that survived Bonferroni correction for the secure state attachment subscale ($F(1,3) = 4.650$, $\eta^2_p = .072$, $p = .013$). Mauchly's test of sphericity was violated ($\chi2(5) = 71.655$, $p = .000$) so the effect was Greenhouse-Geisser corrected. For anxious state attachment, no main effect occurred after controlling for priming order ($F(1,3) = 1.741$, $\eta^2_p = .028$, $p = .160$).

Follow-up analyses are presented in Table 1. There was no mere priming effect on secure state attachment by the neutral prime, as expected. Supporting our hypothesis, the secure attachment prime led to an increase in secure state attachment compared to baseline state attachment. However, the avoidant attachment prime did not lead to a decrease in secure state attachment as hypothesized. Thus, only effects were found for the secure attachment prime on secure state attachment. This might suggest that the avoidant prime worked less well relative to the secure attachment prime, as also suggested by the manipulation checks. Therefore, in the analyses of our second hypothesis, we decided to only focus on the secure attachment prime. When we left out the avoidant attachment prime in the repeated measures ANOVAs conducted to test our first hypothesis (resulting in only three within-subject levels: baseline state attachment, state attachment after neutral prime and state attachment after the secure prime), the effects of the secure attachment prime on secure state attachment remained significant for the secure state attachment subscale

Table 1. Follow-up Analyses on Secure State Attachment (Saq), Controlled for Prime Order.

(I) SAQ	(J) SAQ	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval for difference	
					Lower bound	Upper bound
Baseline	Neutral prime	−1.574	1.181	1	−4.796	1.648
	Secure attachment prime	−4.510	1.478	.020	−8.543	−.478
	Avoidant attachment prime	−3.800	1.696	.172	−8.426	.826

of the SAQ ($F(1,2) = 4.600$, $\eta^2_p = .135$, $p = .014$). For anxious state attachment, again no main effect occurred after controlling for priming order ($F(1,2) = 1.434$, $\eta^2_p = .046$, $p = .247$).

Research Question 2: Is The Effect of Attachment Priming Moderated by Trait Attachment Security or State Attachment Volatility?

We tested the moderating effect of three variables on the association between individual differences in state attachment security after secure attachment priming versus neutral priming. First, we tested the moderating effect of self-reported secure trait attachment in the association between secure state attachment after the neutral prime and secure state attachment after the secure attachment prime (Q2a) and we found it to be significant ($B = -.475$, $p < .001$, see Figure 2).

Exploring the interaction effect, scores of one standard deviation below the mean secure state attachment were labeled low and scores of one standard deviation above the mean secure state attachment were labeled high. For children scoring low on secure state attachment after the neutral prime, the secure attachment prime activated significantly higher levels of secure state attachment in children with higher self-reported secure trait attachment than in children with lower self-reported secure trait attachment (see Figure 2). Further, children with lower levels of self-reported secure trait attachment differed in their level of secure state attachment after the secure attachment prime, depending on their level of secure state attachment after the neutral prime. If these children scored lower on secure state attachment after the neutral prime, the secure attachment prime was significantly less effective in evoking more secure state attachment than when children scored higher on secure state attachment after the neutral

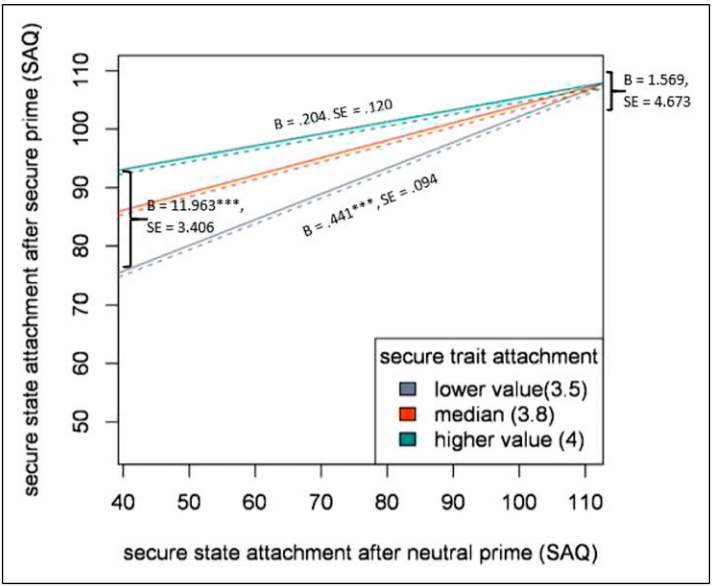

Figure 2. Moderation of trait attachment security measured by PIML questionnaire in the link between secure state attachment after the neutral prime and secure state attachment after the secure prime (SAQ). *$p < .05$, **$p < .01$, ***$p < .005$.

prime. Thus, self-reported secure trait attachment moderated individual differences in the relation between secure state attachment in response to secure and neutral attachment priming. We repeated the same analysis with SBS knowledge as moderator (Q2a). However, SBS knowledge did not moderate the association between secure state attachment after the neutral prime and secure state attachment after the secure attachment prime ($B = -.099$, $p = .404$).

In a second step, we tested the moderation effect of state attachment volatility in the association between secure state attachment after the neutral prime and after the secure attachment prime (Q2b). The moderation was significant ($B = -.681$, $p = .003$) (see Figure 3). Exploring the interaction effect, scores of one standard deviation below the mean level of state attachment volatility were labeled low and scores of one standard deviation above the mean level of state attachment volatility were labeled high. In line with the moderation effect of self-reported secure trait attachment, for children scoring low on secure state attachment after the neutral prime measured by SAQ, the secure attachment prime was significantly more effective in evoking more secure state attachment in children with higher state attachment volatility

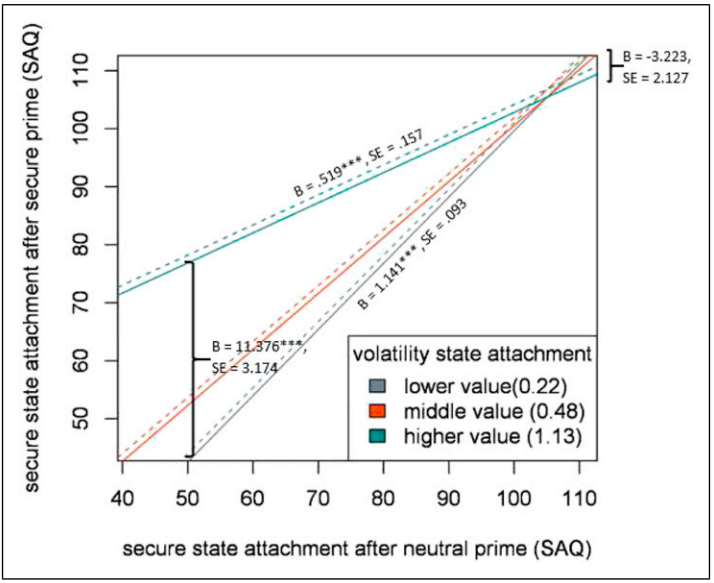

Figure 3. Moderation of state attachment volatility 7 days prior to the secure attachment prime in the link between secure state attachment after the neutral prime and secure state attachment after the secure prime (SAQ). *$p < .05$, **$p < .01$, ***$p < .005$.

than in children with lower state attachment volatility. This illustrates that children who were more volatile in their levels of state attachment security over the 7 days before the secure attachment prime, were more responsive to attachment priming when their level of secure state attachment after the neutral prime was low. Thus, secure attachment priming was more effective when children were higher on volatility of state attachment, explaining individual differences in secure state attachment.

Sensitivity Analyses

First, all results were recalculated with secure state attachment measured with the VAS scale as a means of robustness check. The results remained similar to results with secure state attachment measured with the SAQ (see Supplementary file 1). Second, to evaluate the extent to which the accuracy of the reported memories after the primes determined the effects, we conducted a sensitivity analysis that only included children who reported an accurate autobiographical memory after the primes. The main effect remained significant, but follow-up contrast effects disappeared, likely due to reduced power (see Supplementary file 2 for the detailed analyses). In an additional

analysis we looked at the interaction between reported memory accuracy and secure state attachment memory. The interaction and main effect were not significant (see Supplementary file 2). Overall, this suggested that the accuracy of the memories reported after the primes had no strong influence on the priming effects.

When conducting the sensitivity analysis in which we only included children who reported an accurate autobiographical memory after both primes, the moderation effect of self-reported secure trait attachment disappeared, but the moderation effect of state attachment volatility remained (see Supplementary file 2). When we additionally looked at the interaction of reported memory accuracy and the three moderators in the association between secure state attachment after the neutral prime and secure state attachment after the secure prime, there were no significant three-way interaction effects between accuracy of the reported secure attachment memory, secure state attachment and the three moderators (see Supplementary file 2).

In addition, because the avoidant state attachment scale of the SAQ was not internally consistent, we repeated the analyses for each item of the avoidant state attachment scale separately. Only on the first item "*at this moment, I feel I would rather solve my problems alone*", the scores significantly decreased after both the secure and the avoidant attachment prime in relation to the baseline. However, for the other two items of the avoidant state attachment scale "*at this moment, I'd rather not ask my mother for help*", and "*at this moment, it would not help to talk to my mother*", no significant changes in scores were observed after the primes compared to baseline. One should thus abstain from interpreting the significant effect on just one item of this scale. No further moderation effects appeared significant for the first item (see Supplementary file 3).

Discussion

The current study aimed to investigate the individual differences in state attachment in response to secure attachment priming and how they relate to individual differences in state attachment responses to neutral priming in 9 to 13-year-old children. Additionally, we explored three different possible moderators that could explain individual differences in the effectiveness of attachment priming: self-reported secure trait attachment, secure base script knowledge, and state attachment volatility. After a secure attachment prime, secure state attachment significantly increased compared to after neutral priming, and this effect was most pronounced for children reporting higher secure trait attachment and showing higher state attachment volatility the week prior to the attachment prime. SBS knowledge did not moderate this link. Additionally, the secure attachment prime had no influence on anxious

state attachment levels. Last, the avoidant attachment prime did not alter state attachment levels in these children.

Regarding our first research question (Q1), we found a secure attachment priming effect on state attachment security in children. Adding to prior state attachment priming research that solely focused on adults (Mikulincer & Shaver, 2007; Gillath et al., 2008), the current study suggests that attachment primes can influence state attachment security in childhood as well. The current findings also expanded prior attachment priming research in adults that only found priming effects on state attachment security towards partners, but not towards parents (Bosmans, Bowles, et al., 2014). The current results suggested that attachment primes can also alter parent-oriented attachment states. This observation is congruent with the prediction formulated by Bosmans, Bowles, et al. (2014) that state attachment security towards parents might be more easily primed in childhood. They conjectured that state attachment towards parents is more easily affected by primes in childhood because the development of attachment towards parents is not yet as fixed as in adulthood (e.g., Waters et al., 2021) and because the expectations about relationships with important others are less crystallized (Braet et al., 2012). A strength of the current findings in comparison to past priming research is that we used a within-subject design that allowed us to compare children's state attachment levels after different types of primes. Thanks to this design, we could see that state attachment levels within children only changed after the secure state attachment prime and not after the neutral prime. Hence, the current study allows a firmer conclusion that the prime had a causal effect on the observed change in state secure attachment.

However, one should remain cautious in interpreting these results for two reasons. First, the avoidant prime did not decrease secure state attachment. It could be that insecure primes have less effect on secure state attachment, but such an explanation contradicts the effectivity of insecure attachment primes observed in adult research (e.g., Green & Campbell, 2000; Carnelley et al., 2016; Clear & Zimmer-Gembeck, 2017). One possible explanation is that our avoidant attachment prime failed to prime insecure attachment. Children were asked to recall a memory in which they felt stress but did not seek mother's help. This might have merely primed autonomous coping which is in this age group a feature of secure attachment (Bosmans & Kerns, 2015). Another possible explanation is that an avoidant attachment prime is less effective than an anxious attachment prime. Avoidantly attached children struggle to access attachment memories (Dykas et al., 2014). So, it is not unlikely that avoidant primes prevent children from accessing insecure attachment memories. In support of this concern, we found that only 66% of the participants in our sample reported a specific avoidant attachment memory after the avoidant prime. Reduced activation of attachment memories could render a prime less effective (Bermeitinger et al., 2011; Caviezel et al., 2020). Future research

should compare the impact of using anxious versus avoidant attachment primes to assess the extent to which insecure primes decrease children's secure state attachment.

Second, we found no support for our hypothesis that a secure attachment prime decreases anxious and avoidant state attachment. Because of the low internal consistency of the avoidant state attachment scale, we had to remove this scale from the analyses, due to which we could only partially test our hypothesis (but see Supplementary File 3 for analyses on item level). Further, we found no priming effects on anxious state attachment. Therefore, it is not surprising that the current study was unable to replicate previous adult priming research where secure attachment priming decreased anxious state attachment (Bosmans, Bowles, et al., 2014; Carnelley & Rowe, 2007; Gillath et al., 2009). One possible explanation could be that the priming procedure used in the current study differed from previously used priming procedures. For example, in contrast to prior research (Bosmans, Bowles, et al., 2014; Carnelley & Rowe, 2007; Gillath et al., 2009), children were not asked to write down their attachment memories (to avoid impact from less developed writing skills), but recounted their memory to the experimenter. Prior research suggests that writing procedures result in stronger priming effects (Langens & Schüler, 2005). Hence, it would be interesting to test whether insecure priming effects in children increase when using written primes. In addition, it could prove helpful to ask children explicitly to visualize the attachment figure (e.g., Baldwin, 2019), or to use repeated attachment primes (Carnelley & Rowe, 2007). The latter is in line with research showing that restoring secure state attachment levels requires not one but multiple corrective learning trials (Bosmans et al., 2019). Therefore, future research should test whether multiple attachment primes are more effective to increase state secure attachment in children.

Also, the results seemed not to be affected by the format of the state attachment questions as can be inferred from similar results with another state attachment measure (see Supplementary file 1). When we explored the extent to which the accuracy of the reported attachment memories affected the results, we found that the effects remained comparable when only including children with accurate memories in the analyses and that accuracy did not moderate priming effects. Some effects did not reach significance anymore, likely due to a power decrease, but remained similar in effect size and direction. This suggests that regardless of whether the reported attachment memory was accurate, the secure priming effect influenced the level of state attachment security. Past research suggests that priming effects occur at least partly at a more automatic level, while reporting attachment memories occurs at a more strategic level of processing (Mikulincer et al., 2011). Some children might have struggled to verbalize memories, other children might have refused to disclose insecure attachment memories to the researchers.

Nevertheless, the results do suggest that the primes activated memories independent of what children wanted or were able to share.

The current results show that like in adults, children's state attachment security levels can change after attachment priming compared to after neutral priming. Although studies have found that real life interactions with attachment figures can change state attachment on the short-term (e.g., Schreiber et al., 2021), the current study suggests that these interactions might not be necessary. It has been proposed that priming, in the current study reading about an attachment-related interaction, activates a system of similar autobiographical experiences (Canterberry & Gillath, 2013). The theoretical implication thus suggests that indirect experiences, such as reading about an attachment-related interaction or recalling autobiographical attachment memories, are sufficient to alter state attachment security levels. This might be important for future research regarding appropriate attachment primes without them being unethical or invasive.

For our second research question, we explored three possible moderators of the link between individual differences in secure state attachment after neutral priming and individual differences in secure state attachment after secure attachment priming. First, trait attachment security (self-reported secure trait attachment and secure base script knowledge) was studied as a possible moderator (Q2a) and in a second step, state attachment volatility was tested as moderator (Q2b). First, we found that explicit, self-reported trait attachment significantly moderated priming effects. When secure state attachment after the neutral prime was lower, children with higher self-reported secure trait attachment levels increased significantly more in secure state attachment after the secure attachment prime than children with lower secure trait attachment levels. However, the moderation effects disappeared in the sensitivity analyses with accuracy of attachment memories (see Supplementary file 2), but direction and effect sizes remained similar. Again, lack of power could have caused the effects to disappear. Our findings for self-reported trait attachment might thus be a first indication that trait attachment does act as a moderator of priming effects and that attachment primes are most effective for more securely attached children. This could mean that those children's decreased secure state attachment can be more easily restored, maybe because they have more secure memories that can be reactivated by a prime or because they react less defensively to such primes because their past attachment learning history is positive enough to quickly restore their secure state attachment levels (Bosmans et al., 2019).

We did not find significant moderation effects with SBS knowledge in the link between secure state attachment after the neutral prime and after the secure attachment prime. This could mean that the moderator effect is limited to tests with self-report measures of trait and state attachment security. This raises the concern that the moderator effect merely reflects a shared method

effect. So, for now, the conclusion that trait and state attachment are at interplay is not unequivocal. Prior state attachment research in middle childhood did not find moderating effects of trait attachment security on children's changes in state attachment security after experiencing maternal support during distress (Vandevivere et al., 2018). So, it could be that such moderator effects are hard to find in children. One reason might be related to the fact that attachment security development is still ongoing (Groh et al., 2014). For SBS knowledge to moderate the priming effect, it might have to be more crystallized. SBS crystallization seems to occur more towards late adolescence/young adulthood (Waters et al., 2019). So, testing SBS knowledge as a measure of trait attachment as a moderator might have been premature in this sample.

Second, we explored whether state attachment volatility affects the likelihood that attachment primes influence state attachment. We found that children who scored low on secure state attachment after the neutral prime were more susceptible to the secure attachment prime when they scored high on state attachment volatility in the week preceding the secure attachment prime session. These children showed a significantly greater increase in secure state attachment after the secure attachment prime than children with less state attachment volatility. This suggests that some children are more open to react to, or experience more changes in the attachment context (as observed by Bakermans-Kranenburg & van IJzendoorn, 2007) and that this renders children more susceptible to the impact of attachment primes. Also, when we looked at the subsample of children who reported an accurate attachment memory, the moderation effect of state attachment volatility remained significant (see Supplementary file 2).

Limitations

Although the current study revealed that secure attachment priming can influence short-term state attachment security levels, some limitations need to be taken into account. First, our sample was homogeneous regarding attachment related measures, family status and educational level of mothers. We only had a response rate of 23.6%, which is rather low. One possible reason is that parents were reluctant to invest 2 weeks of their children's time as well as their own time in this research. Children were recruited from a healthy population, which increases the risk that results are affected by self-selection bias (Sharma, 2017). This may have resulted in a sample of parents (and their children) with higher educational levels who often have more experience with research and provide more stable family circumstances. Parents and children who do experience difficulties with attachment or belong to minority groups might have been reluctant to participate (Costigan & Cox, 2001). However, our sample recruitment approach did increase the likelihood that we have

uncovered basic phenomena that are part of normative attachment development (Sharma, 2017).

Second, the state attachment questionnaire we used in the current study was adapted from a state attachment questionnaire for adults (SAAM; Gillath et al., 2009) so, more research is needed to further establish the validity and relevance of this questionnaire to understand children's attachment development. Especially regarding the avoidant state attachment scale, which had low internal consistency in the current study, more research is needed. Importantly, the results we found with the secure state attachment scale of this measure were comparable with the results of a visual analogue scale measuring state attachment security (see Supplementary file 1). This adds to the limited research regarding state attachment in middle childhood, suggesting at least that the phenomenon we revealed is not dependent on the exact wording of the secure state attachment questions. Additionally, we only measured state attachment security towards mother, ignoring how primes affect state attachment security towards father. Including primes and questions focused on attachment towards father would have added substantial burden to an already intensive study. Nevertheless, as a result we cannot be confident that the results would generalize across different attachment relationships.

Third, effects were found with self-reported questionnaire data. State attachment and trait attachment or state attachment volatility questionnaires were all answered by the child and vocabulary used in those questionnaires was sometimes similar. Therefore, we cannot exclude that effects were subject to shared method or semantic overlap biases and results should be interpreted cautiously (Lakoff & Johnson, 1999; Alloway et al., 2020). Although past priming research in other domains found that it is unlikely that primes have only a semantic effect (Alloway et al., 2020), more research is needed to evaluate attachment prime effects on state attachment in middle childhood.

The fact that we did not find moderation effects with SBS knowledge, which is a more implicit measure of trait attachment, may add to the concerns about the results reflecting design-related biases. However, as mentioned previously, it could also be that SBS knowledge was not yet crystallized enough in children of this age group to find effects. Future research could evaluate whether prime effects can also be observed in attachment behavior as previous research did (Crowell, 2003). However, a single prime might be insufficient to impact behavior (Rowe et al., 2020). Moreover, the current study's approach to rely on past attachment priming research designs and to use state attachment questionnaires to evaluate the impact of the prime was an important first step in childhood attachment prime research. It allowed for aligning the current findings to the existing (adult-focused) literature. Our findings fit with that literature, but also open avenues to further adapt the design to younger children and to expand the paradigm to study childhood-relevant research questions with more powerful priming and observational measures.

Implications

We found that in middle childhood state attachment can vary in response to contextual and cognitive attachment-related stimuli induced by the attachment priming procedure. The current findings expand the insights on state attachment fluctuations and could inform new research on the development of trait attachment. First, they provide more insight into individual differences in attachment development in children. Building on a recently formulated learning theory of attachment (Bosmans et al., 2020), it seems safe to assume that new, corrective learning experiences can increase or decrease children's secure trait attachment. However, previous experiences may not all be erased, although some older knowledge may be overwritten by new experiences. Some previous experiences might still be reactivated resulting in past behavioral patterns returning (e.g., Bouton, 2000; Vervliet et al., 2013). Such variability have been described before in longitudinal trait attachment research (Sroufe et al., 1993) and priming contextual cues might prove one of the mechanisms.

Second, the current study suggests that it is worthwhile to look into attachment development and related volatility in state attachment because of its clinical relevance. There is an increasing interest in therapeutic interventions aimed at stimulating children's secure attachment development. Some of these interventions (e.g., VIPP-SD, Juffer et al., 2017; ABFT, Diamond et al., 2003) proved effective to promote children's secure attachment to parents. The current findings support the idea that exposing children to secure attachment experiences can contribute to short-term elevations in secure state attachment. According to the learning theory of attachment (Bosmans et al., 2020), repeated activation of secure attachment states can in the long run promote secure trait attachment development. Therefore, a clinical implication of the current study is that therapeutic interventions exposing children to secure attachment interactions with parents could be beneficial to stimulate children's secure attachment development (Bosmans et al., 2022).

Appendix

Neutral Prime

Here you see a description of a watering can. You can use a watering for gardening. You can put water in it and then water the flowers or plants with it. It goes as follows: you put the opening of the watering can under the running tap and when there is enough water in it, you close the tap. Then you walk towards a flower or plant and lift the watering can in a way that water can pour out of it. A watering can is usually made out of plastic, but it could also be made out of iron. You can hold a watering can with its handle and you

store it usually in a garden shed. There are watering cans in different sizes and colors.

Now we want to ask you to describe a shovel in a similar way. What is it used for?

Secure Attachment Prime

This is the story of Erik. He had a big problem at school. Every day he was bullied at the playground. Two kids at the playground called him names, teared his school bag, and hurt him every time they were together. Erik felt worse every day, until he told his mother about what was happening at school. She comforted Erik and Erik felt like his mother understood him. She talked with him and together they came up with a plan about how to deal with these kids. Bit by bit, things got better at school. Erik was very happy that his mother had helped him and felt how much his mother loved him.

Now we want to ask you to recall a situation in which you had an experience like Erik's. Can you describe a situation in which you needed help and support and your mother was there for you?

What was the problem?

How did your mother help you?

How did it make you feel better?

Avoidant attachment prime:

This is the story of Erik. He had a big problem at school. Every day he was bullied at the playground. Two kids at the playground called him names, teared his school bag, and hurt him every time they were together. Erik felt worse every day. Erik's mother wanted to comfort him, but Erik was too sad and rather liked to be alone and not talk about his problems with his mother. He liked to keep his feelings for himself. His mother insisted to comfort him, but that made Erik feel irritated. Erik felt that he did not need her comforting and did not want anyone to come close. He just wanted to be left alone. It felt as if his mother wanted to be close to him, but he did not want to have anyone coming close.

Now we want to ask you to recall a situation in which you had an experience like Erik's. Can you describe a situation in which you did not feel well, but you did not want your mother to come close or helping you.

What was the problem?

How did you feel at that moment?

How did you feel afterwards?

Within-subject design

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Supplemental Material

Supplemental material for this article is available online.

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Marian Bakermans-Kranenburg is professor at Vrije Universiteit Amsterdam. Her research focuses on attachment and emotion regulation in parents and their children, with special emphasis on neurobiological processes in parenting and development. Her academic interests include the interplay between nature and nurture, neural and hormonal correlates of parenting, and interventions to support parents and professional caregivers.

Angela Rowe is an Associate Professor in Social Psychology at the University of Bristol, UK. Her research centres on the processes and mechanisms that drive adult attachment and the way that attachment styles and attachment-relevant hormones influence thought, behaviour and mental health. While insecure attachment styles represent a vulnerability for the development and maintenance of ill mental health, secure attachment acts as a buffer against its development.

Eva Ceulemans is Professor in the Research Group of Quantitative Psychology and Individual Differences at KU Leuven. After focusing on dimension reduction and clustering methods in her early career, she recently established an innovative research program to develop and evaluate time series methods for capturing dynamic patterns in intensive longitudinal data as well as changes in these patterns across time. She currently also invests in developing methods to evaluate the quality of the obtained statistical output in terms of power and predictive accuracy, and how to optimize this quality through clever design choices.

Guy Bosmans is full professor of clinical child and adolescent psychology at the KU Leuven. He conducts middle childhood research on the development of attachment and on the role of attachment in the development and treatment of psychopathology. He is academic head of the KU Leuven Cognitive Behavior Therapy and Attachment-based Family Therapy trainings.